

Turbo-taxonomy to assemble a megadiverse lichen genus: seventy new species of *Cora* (*Basidiomycota: Agaricales: Hygrophoraceae*), honouring David Leslie Hawksworth's seventieth birthday

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Hawksworth, one of the preeminent figures in mycology and lichenology in the past 50 years. Based on an updated phylogeny using the ITS fungal barcoding locus, we now recognize 189 taxa in a genus that until recently was considered to represent a single species; including this contribution, 92 of these are formally recognized, including five taxa based on historical names or collections that have not been sequenced. Species of *Cora* can be recognized by a combination of morphological (size, colour, lobe configuration, surface hairs, hymenophore size and shape), anatomical (thallus thickness, cortex structure, photobiont type, hyphal papillae), and ecogeographical features (substrate, habitat, distribution), and a keytable allowing the identification of all accepted taxa is provided. The new species are: *Cora accipiter* Moncada, Madriñán & Lücking spec. nov., *C. applanata* Moncada, Soto-Medina & Lücking spec. nov., *C. arachnodavidea* Moncada, Dal Forno & Lücking spec. nov., *C. arborescens* Dal Forno, Chaves & Lücking spec. nov., *C. arcabucana* Moncada, C. Rodríguez & Lücking spec. nov., *C. aturucua* Lücking, Moncada & C. Vargas spec. nov., *C. auricleslia* Moncada, Yáñez-Ayabaca & Lücking spec. nov., *C. barbifera* Moncada, Patiño & Lücking spec. nov., *C. boleslia* Lücking, E. Morales & Dal Forno spec. nov., *C. caliginosa* Holgado, Rivas Plata & Perlmutter spec. nov., *C. campestris* Dal Forno, Eliasaro & Spielmann spec. nov., *C. canari* Nugra, Dal Forno & Lücking spec. nov., *C. caraana* Lücking, Martins & Lucheta spec. nov., *C. casasolana* Moncada, R.-E. Pérez &

Lücking spec. nov., *C. caucensis* Moncada, M. Gut. & Lücking spec. nov., *C. celestino* Moncada, Cabrera-Amaya & Lücking spec. nov., *C. comaltepeca* Moncada, R.-E. Pérez & Herrera-Camp. spec. nov., *C. corani* Lücking, E. Morales & Dal Forno spec. nov., *C. corelleslia* Moncada, A. Suárez-Corredor & Lücking spec. nov., *C. crispoleslia* Moncada, J. Molina & Lücking spec. nov., *C. cuzcoensis* Holgado, Rivas Plata & Perlmutter spec. nov., *C. dalehana* Moncada, Madriñán & Lücking spec. nov., *C. davibogotana* Lücking, Moncada & Coca spec. nov., *C. davicrinia* Moncada, Madriñán & Lücking spec. nov., *C. davidia* Moncada, L. Vargas & Lücking spec. nov., *C. dewisanti* Moncada, A. Suárez-Corredor & Lücking spec. nov., *C. dulcis* Moncada, R.-E. Pérez & Lücking spec. nov., *C. elephas* Lücking, Moncada & L. Vargas spec. nov., *C. fuscodavidiana* Lücking, Moncada & L. Vargas spec. nov., *C. garagoa* Simijaca, Moncada & Lücking spec. nov., *C. gigantea* Lücking, Moncada & Coca spec. nov., *C. gomeziana* Dal Forno, Chaves & Lücking spec. nov., *C. guajalitis* Lücking, Robayo & Dal Forno spec. nov., *C. hafecesweorthensis* Moncada, Lücking & R. Peláez spec. nov., *C. haledana* Dal Forno, Chaves & Lücking spec. nov., *C. hawksworthiana* Dal Forno, P. Nelson & Lücking spec. nov., *C. hochesuordensis* Lücking, E. Morales & Dal Forno spec. nov., *C. hymenocarpa* Lücking, Chaves & Lawrey spec. nov., *C. imi* Lücking, Chaves & Lawrey spec. nov., *C. itabaiana* Dal Forno, Aptroot & M. Cáceres spec. nov., *C. les lactuca* Lücking, Moncada & R. Peláez spec.

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nov., *C. maxima* Wilk, Dal Forno & Lücking spec. nov., *C. minutula* Lücking, Moncada & Yáñez-Ayabaca spec. nov., *C. palaeotropica* Weerakoon, Aptroot & Lücking spec. nov., *C. palustris* Dal Forno, Chaves & Lücking spec. nov., *C. parabovei* Dal Forno, Kukwa & Lücking spec. nov., *C. paraciferrii* Lücking, Moncada & J.E. Hern. spec. nov., *C. paraminor* Dal Forno, Chaves & Lücking spec. nov., *C. pastorum* Moncada, Patiño & Lücking spec. nov., *C. pichinchensis* Paredes, Jonitz & Dal Forno spec. nov., *C. pikynasa* J.-M. Torres, Moncada & Lücking spec. nov., *C. pseudobovei* Wilk, Dal Forno & Lücking spec. nov., *C. pseudocorani* Lücking, E. Morales & Dal Forno spec. nov., *C. putumayensis* L.J. Arias, Moncada & Lücking spec. nov., *C. quillacinga* Moncada, F. Ortega & Lücking spec. nov., *C. rothesiorum* Moncada, Madriñán & Lücking spec. nov., *C. rubrosanguinea* Nugra, Moncada & Lücking spec. nov., *C. santacruzensis* Dal Forno, Bungartz & Yáñez-Ayabaca, spec. nov., *C. schizophylloides* Moncada, C. Rodríguez & Lücking spec. nov., *C. smaragdina* Lücking, Rivas Plata & Chaves spec. nov., *C. soledavidia* Dal Forno, Marcelli & Lücking spec. nov., *C. subdavicrinita* Moncada, J. Molina & Lücking spec. nov., *C. suturifera* Nugra, Besal & Lücking spec. nov., *C. terrestris* Dal Forno, Chaves & Lücking spec. nov., *C. terricoleslia* Wilk, Dal Forno & Lücking spec. nov., *C. udebeceana* Moncada, R. Peláez &

Lücking spec. nov., *C. urceolata* Moncada, Coca & Lücking spec. nov., *C. verjonensis* Lücking, Moncada & Dal Forno spec. nov., *C. viliewoa* Lücking, Chaves & Soto-Medina spec. nov., and *C. yukiboa* Mercado-Díaz, Moncada & Lücking spec. nov. Furthermore, the taxonomic status of the recently described or recognized species *C. arachnoidea*, *C. aspera*, *C. ciferrii*, and *C. reticulifera*, is revised.

Keywords Bolivia · Citizen science · Chile · Mexico · Puerto Rico · Sri Lanka

Introduction

The most recent estimate of global species richness for Eukaryotes cites 8.7 million species, with little more than 1.2 million species described and 7.5 million yet to be discovered (Mora et al. 2011). This estimate is considered conservative, due to the very low underlying estimates for already catalogued species. For instance, Mora et al. (2011) counted approximately 950,000 animal species, 215,000 plant species, and 43,000 fungal species, whereas the correct numbers are substantially higher, with 1.4 million species of animals, 310,000 of plants, and 99,000 of fungi (Chapman 2009). Thus, if the underlying linear model

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detected by Mora et al. (2011) is correct, estimated global species richness would have to be corrected to 13.5 million eukaryote species. Remarkably, while Mora et al. (2011) predicted a total of 611,000 fungal species, the corrected number assuming 99,000 known species would be 1.4 million, which closely matches the independent estimate of 1.5 million species developed by Hawksworth (1991, 2001). Thus, more than 1 million species of fungi remain to be discovered or described.

Compared to other fungi, lichenized fungi have not been considered a substantial source of undiscovered species richness, with approximately 18,500 species currently accepted and a total of 28,000 species predicted (Feuerer and Hawksworth 2007; Lücking et al. 2009; Jaklitsch et al. 2016). In addition, most undiscovered species were assumed to occur in large taxa of crustose microlichens, such as *Graphidaceae* and *Trypetheliaceae* (Lücking et al. 2014a; Aptroot et al. 2016). Yet, recent studies have shown that some conspicuous macrolichens, such as the family *Lobariaceae*, harbour a large proportion of unrecognized species richness (Moncada et al. 2013, 2014a, b). The most striking example is the basidiolichen genus *Cora*, until about a decade ago assumed to represent a single species, but shown to contain hundreds of taxa (Lawrey et al. 2009; Dal Forno et al. 2013; Lücking et al. 2014b). *Cora* lichens are important components of mostly neotropical, montane

to alpine ecosystems, in particularly the unique wet paramos in the northern Andes, and contribute to the nitrogen cycle due to fixation of atmospheric nitrogen through their cyanobacterial photobiont (Feige 1969; Fritz-Sheridan 1988; Wolf 1993; Lange et al. 1994; Thomas et al. 1997). They also appear to be indicators of ecosystem health for the paramos (Lücking et al. 2014b), which are threatened by uncontrolled agricultural and mining activities and urbanization (Hofstede 1995; Global Environment Facility 2003; Murcia et al. 2013). In addition, *Cora* and its relatives have been identified as model organisms to reconstruct the evolution of the lichenized life style in fungi (Dal Forno et al. 2013), although the thallus assembly in these basidiolichens is quite different from what has been recently uncovered in *Parmeliaceae* (Spribille et al. 2016).

Based on work published in the second half of the 20th century, only 37 species of lichenized *Basidiomycota* were recognized in nine genera up to the year 2000 (Petersen 1967; Oberwinkler 1970, 2001; Parmasto 1978; Redhead 1984; Petersen and Zang 1986; Redhead and Kuyper 1987; Jørgensen 1989, 1998; Jørgensen and Ryman 1989; Lutzoni and Vilgalys 1995; Marciano et al. 1996). Within *Dictyonema* s.lat., Parmasto (1978) recognized only one foliose species, *D. pavonium* (Sw.) Parmasto, reducing to synonymy further eleven names previously assigned to

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various genera, viz. *Cora* Fr., *Corella* Vain., *Gyrolophium* Kunze ex Krombh., and *Wainiocora* Tomas. While the name of the single species was subsequently corrected to *D. glabratum* (Spreng.) D. Hawksw. (Hawksworth 1988), the concept of recognizing only a single taxon was widely accepted (Fritz-Sheridan 1988; Wolf 1993; Lange et al. 1994; Thomas et al. 1997; Carbonero et al. 2002; Sasaki et al. 2001; Trembley et al. 2002). For instance, Larcher and Vareschi (1988) attributed morpho-anatomical variation in material now known to comprise at least four species in two genera as habitat-induced, infraspecific variation.

With the onset of molecular research, the classification of lichenized *Basidiomycota* has changed substantially, settling the phylogenetic position of known genera, reinstating genera previously subsumed under synonymy, including *Cora*, and introducing various new genera (Redhead et al. 2002; Ertz et al. 2008; Lawrey et al. 2009; Dal Forno et al. 2013; Hodkinson et al. 2014). One of the most impacting findings was the close relationship of agaricoid, cyphelloid, and corticioid-stereoid, lichenized forms in the genera *Lichenomphalia*, *Cyphellostereum*, *Dictyonema* s.lat. (including *Cora*), as well as the sterile *Acantholichen*, in the single family *Hygrophoraceae* (Lawrey et al. 2009), specifically in the newly established subfamily *Lichenomphalioidae*, tribe *Arrheniae* (Lodge et al. 2014). Increasing focus was also placed on species recognition in lichenized *Basidiomycota*, using the fungal ITS barcoding locus (Schoch et al. 2012; Lücking et al. 2014b). As a result, the number of accepted species of lichenized *Basidiomycota*, including those described herein, has increased dramatically, in particular in the genus *Cora* (Fig. 1) (Chaves et al. 2004; Fischer et al. 2007; Nelsen et al. 2007; Lumbsch et al. 2011; Hodkinson et al. 2014; Sulzbacher et al. 2012; Yáñez et al. 2012;

Lücking et al. 2013a, b, 2014b; Schmull et al. 2014; Vargas et al. 2014; Yanaga et al. 2015; Dal Forno et al. 2016). This corresponds to an increase of the proportion of *Basidiomycota* among lichen fungi from approximately 0.2 % until the year 2000 to 0.9 % currently and 1.6 % predicted by the end of 2017. Although only partially described, over 280 species are currently recognized in the genera *Acantholichen* (8), *Cora* (189; including this study and including five species for which no sequence data have yet been obtained), *Corella* (11), *Cyphellostereum* (15), and *Dictyonema* s.str. (59) (Lücking et al. 2014b; Dal Forno 2015; Dal Forno et al. 2016), which places *Hygrophoraceae* among the 20 fungal families with the largest number of lichenized species and *Cora* among the twenty-five most species-rich, lichenized fungal genera (Jaklitsch et al. 2016). With a predicted number of over 450 species (Lücking et al. 2014b), *Cora* would rank sixth among all lichenized fungal genera, surpassed only by *Xanthoparmelia* (820), *Lecanora* (600), *Arthonia* and *Cladonia* (500), and *Graphis* (460), if current numbers hold up for those genera (Jaklitsch et al. 2016). *Cora* is so far the only large fungal genus literally assembled from the ground up, based on molecular data, with 97 % of is currently distinguished 189 species established by means of ITS barcoding sequences (Lücking et al. 2014b; this paper). The only other lichenized fungal genus with an even higher amount of phylogenetic data is *Peltigera* (Miadlikowska and Lutzoni 2000, 2004; Goffinet et al. 2003; Sérusiaux et al. 2009; Magain et al. 2010; Miadlikowska et al. 2014). The robust phylogenetic framework available for the genus *Cora* allows conclusions about the mechanisms driving speciation and ecomorphological diversification in these lichen fungi (Dal Forno et al. 2013).

The large number of phylogenetically recognized and predicted species in the genus *Cora* generates a logistical

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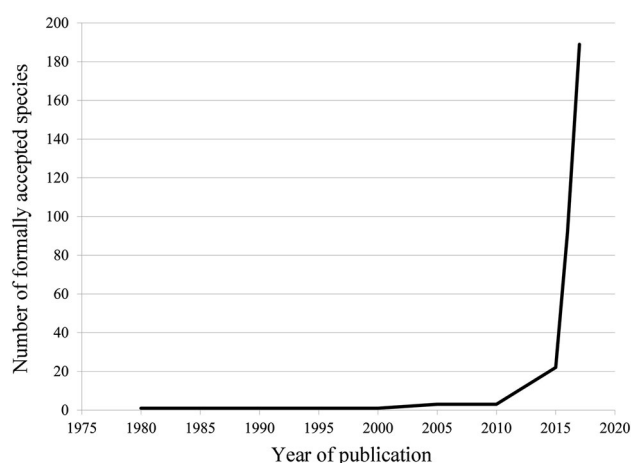


Fig. 1 Increase of recognized species richness in the basidiolichen genus *Cora* between 1980 (after the monograph by Parmasto 1978) and 2017 (assuming all 189 phylogenetically recognized species are formally described by then)

challenge as to their discovery and formal description. In megadiverse groups of organisms, such as insects, this challenge has been successfully addressed with the concept of “turbo-taxonomy”, the simultaneous publication of large numbers of species resulting from molecular barcoding analysis using semi-automated electronic tools, including dynamic databases for phenotype characters than generate standardized descriptions and interactive keys (Butcher et al. 2012; Riedel et al. 2013a, b, 2014; Summers et al. 2014). This concept is here adopted for the first time for a genus of lichen fungi, combining international collaboration to ensure broad geographic coverage, a rigorous application of quantitative phylogenetic methods, a standard protocol for the capture of phenotype features allowing semi-automated descriptions, and registration in online databases, to fast-track the publication of numerous new species and to facilitate their recognition in the field and in herbarium collections. Thus, while Lücking et al. (Lücking et al. 2013a, b, c) provided a first synopsis of 15 species then accepted in *Cora* and 22 taxa were formally recognized prior to this study (Lücking et al. 2014c, 2015; Vargas et al. 2014; Ariyawansa et al. 2015), an additional 70 species are described herein, for a total of 92, or about half of the currently recognized 189 taxa. To this end, we considerably increased molecular sampling of *Cora*, both taxonomically and geographically, including new material from Mexico, Costa Rica, Colombia, Ecuador, Brazil, and Chile, and almost doubled the number of sequenced specimens from 338 to 651.

We are pleased to be able to dedicate this work to our esteemed colleague, Prof. Dr. David Leslie Hawksworth, on the occasion of his seventieth birthday. David Hawksworth is, without doubt, one of the most knowledgeable and prolific figures in the mycological sciences, with nearly

600 publications, including nearly 60 books, and almost 900 new taxa described. Among several high-profile awards, he has been named *Commander of the British Empire* in 1996 and has received the *Acharius Medal* of the International Association for Lichenology in 2002. David has worked and continues to be active in many aspects of mycology and lichenology, focusing on broad nomenclatural issues, fostering the integration of fungal nomenclature, the global assessment fungal diversity, and systematic revisions of neglected groups, including lichenicolous taxa or fungi at the borderline of lichenization. He also has a vested interest in the family *Parmeliaceae* (Crespo et al. 2001, 2010; Hawksworth et al. 2008; Divakar et al. 2015; Núñez-Zapata et al. 2015) and has published on nomenclatural issues regarding *Dictyonema* s.lat., including the taxa now recognized as *Cora* (Hawksworth 1988; Lücking and Hawksworth 2007). Although we had initially intended to dedicate each of the 70 new species described herein etymologically to David and his scientific work, we soon realized that this was too much of a challenge. Nevertheless, we enjoyed coming up with a fairly large number of variations of the name David Leslie Hawksworth and its historical origins and meanings, resulting in 23 direct, although sometimes cryptic dedications, and seven opportunities to honour David indirectly.

Materials and methods

New material of *Cora* was collected between 2012 and 2016 in Mexico, Costa Rica, Puerto Rico, Colombia, Ecuador (including Galapagos), Brazil, Chile, and Sri Lanka. Specimens were studied at The Field Museum (Chicago), George Mason University (Fairfax, Virginia), the Smithsonian Institution National History Museum (Washington), the Botanical Garden and Botanical Museum (Berlin, Germany), and the Universidad Distrital Francisco José de Caldas (Bogotá, Colombia), using standard techniques of light microscopy and, for selected specimens, thin-layer chromatography (Orange et al. 2010). We used a standardized protocol for morphological, anatomical, and chemical characters to describe each species (Lücking et al. 2013a; Vargas et al. 2014). Specimens are deposited at the cited herbaria; all herbarium specimens previously cited as deposited at INB (National Biodiversity Institute, Costa Rica) have now been relocated to CR (National Herbarium at the National Museum, Costa Rica).

Most characters given in the descriptions are self-explaining and are here also documented through illustrations throughout the taxonomic part. Surface colour is one of the most important diagnostic characters but can only be assessed reliably in hydrated specimens; thus, to assess the fresh colour of species for which no field photographs were

available, we carefully rewetted collected specimens, after testing the reliability of this approach using herbarium specimens from which field photographs were available. There are usually three color stages: (1) fully hydrated, in which the colour is more or less uniform and often dark; (2) in the natural process of drying in the field, where more or less distinct concentric zonation between more and less hydrated areas becomes apparent; and (3) fully dried, which corresponds to the colour of well-preserved herbarium material. Anatomically, species of *Cora* are rather uniform, except for the structure of the upper cortex, the coloration of the photobiont layer, and the dimensions of the different thallus layers including the lower medulla. The cortex is typically viaduct-shaped, i.e. composed of an upper layer of periclinal hyphae supported by a lower layer of anticlinal hyphae (Figs. 4K, 5N, 6A); this structure can become diffuse to collapsed (Fig. 8M) or compacted (Fig. 3F), or a cortex can be absent (Fig. 8L). The photobiont layer is either uniformly aeruginous-green (Figs. 3F, 6A) or with olive to orange-brown accessory pigmentation in the upper portion (Figs. 4K, 5N). A newly captured character which needs further study are short, papilliform hyphae formed in the lower medulla in many species (Figs. 3J, 5H, 7G, 11O); their function is unknown but possibly related to water uptake, and their presence appears to be species-specific. While the internal anatomy of the hymenophore is rather uniform and does not provide diagnostic characters, its shape varies substantially between taxa (e.g., Figs. 3M, 4J, O, 6D, M, O, 7C, E, M, O, 8B, 9K, 10L, 11H, J, L). Since lobe length was measured in radial direction, in species where the hymenophore forms concentrically elongate patches (e.g., Figs. 8B, 9K, 11J, L), the length refers to their radial extension whereas the width corresponds to their tangential extension and is therefore usually associated with higher values.

New ITS sequences were generated via Sanger sequencing following previously published protocols (Dal Forno et al. 2013); in a few cases, 454 pyrosequencing was employed to obtain sequences of the target mycobiont (Lücking et al. 2014d). Newly generated sequences were assembled with sequences from our previous study (Online Supplement A) (Lücking et al. 2014b) and aligned with MAFFT 7.294 using the –auto option (Kato and Standley 2013) and then manually corrected, resulting in an alignment length of 855 bases (Online Supplement B). The data set, containing 651 ingroup OTUs, was subjected to maximum likelihood search using RAXML 8.2.8 on the CIPRES Science Gateway server (Miller et al. 2010; Stamatakis 2015), with non-parametric bootstrapping using 500 replicates under the GTRGAMMA model. We employed a Bayesian implementation of the Poisson tree species process (bPTP; Zhang et al. 2013) on the bPTP server (<http://species.h-its.org/ptp>) to assess the potential

number of phylogenetically delimited species in this data set. A subsequent analysis was performed using one sequence per species (the type sequence when available, except for three taxa) for the 87 formally accepted and sequenced taxa, with the same specifications as above, to focus on the relationships between these species; this alignment had a length of 816 bases (Online Supplement C).

In addition to the data presented here, we also assembled a 3-locus phylogeny of a large number of species across the *Dictyonema* clade, to confirm that the topology within *Cora* matches the topology obtained with only the ITS locus (Dal Forno 2015). We also separately obtained 16S data for the photobiont of all *Cora* samples, to confirm that all species associated with photobionts of the genus *Rhizonema* (Dal Forno 2015).

Molecular phylogeny

The best-scoring maximum likelihood tree (Online Supplement D), based on 651 ITS barcoding sequences plus two outgroup OTUs (*Corella*), allows manual delimitation of 184 species, based on a combination of branch support, branch length, and clade correlation with phenotype features including distribution and ecology. In contrast, the bPTP analysis (acceptance rate 0.7397) indicated the presence of between 284 and 426 species (mean 349), which suggests that our manual delimitation is quite conservative, with about half the number of species recognized. The overall topology of the genus, with *Cora* divided into two large, supported clades (Clade A, Clade B), is reflected in both the large and the reduced tree, with the currently 87 formally accepted species (including those described herein) based on one sequence per taxon (Fig. 2).

Although only a single locus was used, the backbone topology is remarkably well-supported, with several larger, supported clades: the *C. minor* clade, including *C. minor*, *C. paraminor*, *C. davicrinata*, *C. pastorum*, *C. rothesiorum*, *C. barbifera*, *C. hirsuta*, and *C. schizophylloides*; the *C. elephas* clade, with *C. gomeziana*, *C. elephas*, *C. rubrosanguinea*, *C. caucensis*, and *C. aturucoa*; the *C. byssoidea* clade, with *C. byssoidea*, *C. dalehana*, *C. putumayensis*, *C. davibogotana*, *C. hafecesweorthensis*, *C. imi*, *C. subdavicrinata*, *C. crispoleslia*, *C. davidia*, *C. arcabucana*, *C. garagoa*, *C. casasolana*, and *C. haledana*; the *C. ciferrii* clade, including *C. pichinchensis*, *C. terricoleslia*, *C. hymenocarpa*, *C. cuzcoensis*, *C. terrestris*, *C. ciferrii*, *C. paraciferrii*, *C. caliginosa*, *C. auriculeslia*, *C. squamiformis*, and a subclade composed of *C. reticulifera*, *C. applanata*, and *C. guajalitensis*; and the *C. aspera* clade, with *C. canari*, *C. hawksworthiana*, *C. minutula*, *C. smaragdina*, *C. fimbriata*, *C. undulata*, *C. yukiboa*, *C.*

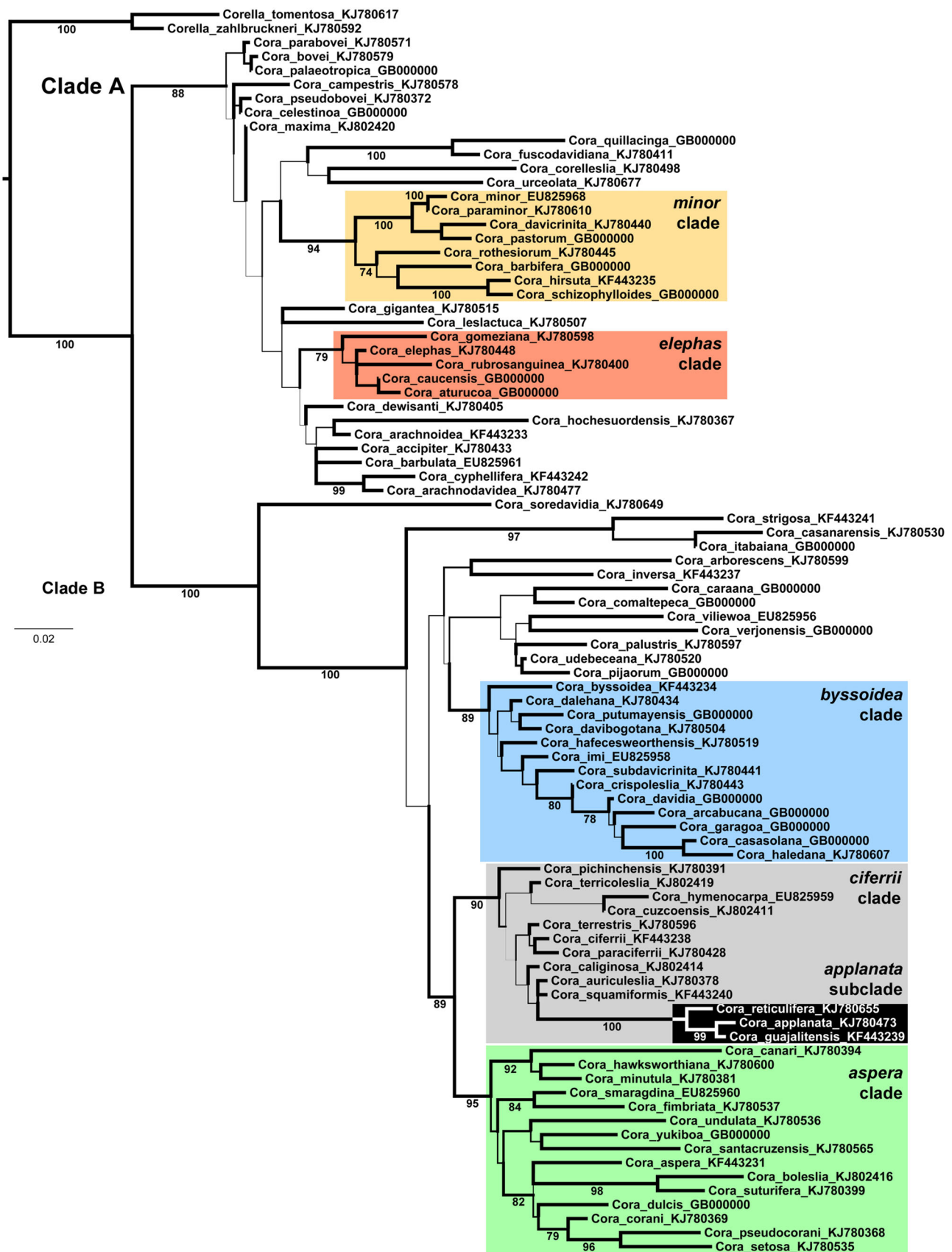


Fig. 2 Best-scoring maximum likelihood tree based on one ITS sequence per taxon (the type sequence except in three species corresponding to historic names) for the 87 formally described species for which sequence data are available. Bootstrap values are indicated below branches and major, supported clades are highlighted

santacruzensis, *C. aspera*, *C. boleslia*, *C. suturifera*, *C. dulcis*, *C. corani*, *C. pseudocorani*, and *C. setosa*.

Although only about half of the 184 phylogenetically distinguished taxa are included in this analysis and a quantitative analysis has not yet been performed, certain phenotypic characters appear to be correlated with these major clades. Thus, the *Cora minor* clade consists mostly of small, epiphytic paramo species that frequently produce surface trichomes or soredia and mostly have a collapsed to compacted cortex; medullary papillae are found in many species of this clade. The *C. elephas* clade is remarkable for the unique, vine-red pigment produced by the species of this clade after rewetting; its members are almost exclusively saxicolous or terrestrial, generally large, with glabrous surface, lacking soralia, with a viaduct-shaped cortex consisting of an upper layer of periclinal and a supporting layer of anticlinal hyphae, and lacking medullary papillae. The *C. byssoidea* clade, while variable in most features, concentrates species with a hymenophore forming rounded, adnate patches resembling the ascomata of the lichenized genus *Myriostigma* (Ascomycota: Arthoniaceae; Frisch et al. 2014). Species of the *C. ciferrii* clade are almost exclusively ground-dwelling (terrestrial or terricolous), lack soralia and in most cases medullary papillae, and are mostly found in montane forest. Finally, the *C. aspera* clade includes mostly epiphytic taxa with more or less green thallus when fresh, frequently forming medullary papillae and growing mostly in montane forest.

Taxonomic treatment

In the following account, 70 new species of *Cora* are formally described. Due to space limitations and because over one hundred species remain to be formally described, we refrained from assembling a dichotomous key at this point and instead provided a diagnostic, synoptic key table for quick species identification (Table 1). A novel, rapid identification tool for the genus using the method of phylogenetic binning is also under way (Lücking et al. 2016). In the course of translating the newly available phylogeny into a formal classification, we also critically revised some of the previously described species, which were based on a much reduced molecular data set (Lücking et al. 2013a). As a result, the following taxa are here redefined: *Cora arachnoidea* J.E. Hern. & Lücking (see discussion under *C. accipiter*, *C. dewisanti*, and *C. maxima*), *C. aspera* Wilk,

Lücking & E. Morales (see discussion under *C. boleslia* and *C. pseudocorani*), *C. ciferrii* (Tomas.) Lücking, Grall & Thüs (see discussion under *C. paraciferrii*), and *C. reticulifera* Vain. (see discussion under *C. applanata*).

The new species

Cora accipiter Moncada, Madriñán & Lücking spec. nov.

Index Fungorum: 552381; *Faces Of Fungi*: 02536; Fig. 3A–C

Etymology: The scientific name *accipiter*, here used as a noun in apposition, refers to a series of species of hawks of the genus *Accipiter* (Ferguson-Lees and Christie 2001). The present lichen does indeed have wing-shaped lobes and hence this epithet seems appropriate. The connection to David Hawksworth is given by the notion that the personal name ‘Hafoc’, from which the last name Hawksworth is ultimately derived (Mills 2011; Harrison 2013), apparently was first given to someone who resembled a hawk. According to Kabalarian philosophy, however, there is a deeper meaning than just hawk-resemblance in the name ‘Hafoc’, giving its bearer a responsible, reserved, and dignified nature, able to find success in anything the person undertakes, attributes which certainly describe David’s career well. As such, the name ‘Hafoc’ should not be confused with the contrasting and unrelated word ‘havoc’, meaning a situation of much confusion, disaster, destruction or devastation.

Holotype: Lücking & Moncada 34011 (ANDES).

ITS barcoding sequences: KJ780433 (holotype), KF44 3232, KJ780430, KJ780453, KJ780464, KJ780478, KJ780 494, KJ780495, KJ780501, KX772681, KX772691, KX772 499, KX772592, KX772593, KX772594, KX772597, KX7 72600, KX772602, KX772603 (paratypes).

Diagnosis: A medium-sized to large, (sub-)epiphytic *Cora* with light olive-green to green-grey colour, concentrically arachnoid-tomentose upper surface, and fan-to wing-shaped, laterally truncated lobes with free sutures.

Thallus (sub-)epiphytic, at the base or the lower stem of shrubs or on the ground growing on herbaceous plants including grasses, foliose, up to 20 cm across, composed of 5–15(–25) fan- to wing-shaped, usually ascending, imbricate lobes; individual lobes 2–3 cm wide and 1–3 cm long, rather frequently branched and with long, radial branching sutures, soon rupturing along the sutures and lobes therefore laterally truncated. Surface light olive to olive-brown when fresh, with slight concentric colour zonation, with thin but distinct, involute, pale margins, becoming yellowish grey in the herbarium. Upper surface slightly to distinctly undulate when fresh, undulate-rugose when dry, shortly arachnoid-tomentose in concentric zones; involute margins thinly pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish to

Table 1 Sorted keytable using selected and simplified phenotypic characters to identify formally accepted species of *Cora* for which also ITS barcoding sequences are available

Substrate	Lobe width	Soredia	Surface trichomes	Sutures	Hymenophore	Colour	Papillae	Cortex	Surface	Margin trichomes	Distribution	Habitat	Species
Saxicolous	Small (to 1 cm)	Present	–	–	–	Brown	–	Viaduct	(Even)	–	Northern Andes	Andine	<i>fuscodavidiana</i>
Saxicolous	Medium (1–3 cm)	–	Present	–	Concentric	Olive	Present	Viaduct	Even	Present	Central Andes	Forest	<i>strigosa</i>
Saxicolous	Medium (1–3 cm)	–	–	Short	Concentric	Olive	–	Viaduct	(Undulate)	–	Brazil	Andine	<i>campestris</i>
Saxicolous	Medium (1–3 cm)	–	–	–	Concentric	Green	–	Viaduct	Undulate	–	Northern Andes	Forest	<i>undulata</i>
Saxicolous	Medium (1–3 cm)	–	–	–	–	Olive	–	Viaduct	Even	Present	Northern Andes	Forest	<i>leslactuca</i>
Saxicolous	Large (over 3 cm)	–	–	Distinct	–	Olive	Present	Viaduct	(Undulate)	–	Northern Andes	Forest	<i>casanarensis</i>
Saxicolous	Large (over 3 cm)	–	–	Short	Concentric	Olive	–	Viaduct	(Undulate)	–	Northern Andes	Forest	<i>davibogotana</i>
Saxicolous	Large (over 3 cm)	–	–	–	Subcyphelloid	Green	–	Viaduct	Undulate	Present	Northern Andes	Forest	<i>aturucoa</i>
Saxicolous	Large (over 3 cm)	–	–	–	Concentric	Olive	–	Viaduct	Even	Present	Northern Andes	Andine	<i>elephas</i>
Terricolous	Small (to 1 cm)	–	Present	–	Cyphelloid	Green	Present	Viaduct	Even	Present	Northern Andes	Andine	<i>hirsuta</i>
Terricolous	Small (to 1 cm)	–	–	–	–	Olive	–	Compacted	Even	–	Northern Andes	Andine	<i>auriculeslia</i>
Terricolous	Small (to 1 cm)	–	–	–	–	Brown	–	Collapsed	Rugose	–	Central Andes	Andine	<i>pseudobovei</i>
Terricolous	Small (to 1 cm)	–	–	–	–	Brown	–	Compacted	Rugose	Present	Central Andes	Andine	<i>terricoleslia</i>
Terricolous	Small (to 1 cm)	–	–	–	–	Brown	–	Compacted	Rugose	Present	Central Andes	Andine	<i>squamiformis</i>
Terricolous	Small (to 1 cm)	–	–	–	–	Brown	–	Compacted	Rugose	–	Southern Andes	Temperate	<i>bovei</i>
Terricolous	Small (to 1 cm)	–	–	–	–	Brown	–	Compacted	(even)	–	Northern Andes	Andine	<i>urceolata</i>
Terricolous	Medium (1–3 cm)	–	–	–	Concentric	Green	–	Viaduct	(Undulate)	–	Northern Andes	Forest	<i>guajalicensis</i>
Terricolous	Medium (1–3 cm)	–	–	–	Concentric	Green	–	Compacted	(Undulate)	–	Brazil	Forest	<i>reticulifera</i>
Terricolous	Medium (1–3 cm)	–	–	–	–	Green	–	Compacted	(Undulate)	–	Northern Andes	Forest	<i>applanata</i>
Terrestrial	Small (to 1 cm)	Present	–	–	–	Green	Present	Compacted	Rugose	Present	Northern Andes	Andine	<i>quillacinga</i>
Terrestrial	Medium (1–3 cm)	–	Present	Long	Concentric	Brown	–	Viaduct	(Undulate)	Present	Northern Andes	Andine	<i>accipiter</i>
Terrestrial	Medium (1–3 cm)	–	Present	Short	Subcyphelloid	Olive-brown	–	Viaduct	Even	–	Northern Andes	Andine	<i>dewisanti</i>
Terrestrial	Medium (1–3 cm)	–	Present	–	Cyphelloid	Olive-brown	Present	Viaduct	Even	Present	Northern Andes	Andine	<i>arachnodavidea</i>
Terrestrial	Medium (1–3 cm)	–	(Present)	Short	Concentric	Olive	–	Viaduct	(Undulate)	–	Central Andes	Forest	<i>caliginosa</i>
Terrestrial	Medium (1–3 cm)	–	–	Short	Concentric	Green	Present	Collapsed	Even	–	Mexico	Forest	<i>dulcis</i>
Terrestrial	Medium (1–3 cm)	–	–	Short	Concentric	Green	–	Collapsed	Undulate	–	Central America	Forest	<i>palustris</i>
Terrestrial	Medium (1–3 cm)	–	–	Short	Concentric	Olive	–	Viaduct	(Undulate)	–	Central America	Forest	<i>terrestris</i>
Terrestrial	Medium (1–3 cm)	–	–	–	Concentric	Green	–	Viaduct	Even	Present	Northern Andes	Andine	<i>caucensis</i>
Terrestrial	Medium (1–3 cm)	–	–	–	–	Green	Present	Viaduct	Even	–	Mexico	Andine	<i>casasolana</i>
Terrestrial	Medium (1–3 cm)	–	–	–	–	Olive	–	Collapsed	Undulate	–	Northern Andes	Andine	<i>celestino</i>
Terrestrial	Medium (1–3 cm)	–	–	–	–	Brown	–	Ecorticate	(even)	–	Sri Lanka	Forest	<i>palaeotropica</i>
Terrestrial	Medium (1–3 cm)	–	–	–	–	Brown	–	Compacted	(Undulate)	–	Northern Andes	Andine	<i>pichinchensis</i>
Terrestrial	Large (over 3 cm)	–	Present	Long	Concentric	Green	–	Collapsed	(Undulate)	Present	Central Andes	Andine	<i>parabovei</i>
Terrestrial	Large (over 3 cm)	–	–	Long	Adnate-confluent	Blue-green	Present	Viaduct	Undulate	–	Northern Andes	Forest	<i>hafecesweorthensis</i>
Terrestrial	Large (over 3 cm)	–	–	Long	Concentric	Blue-green	–	Viaduct	Undulate	–	Central America	Andine	<i>imi</i>
Terrestrial	Large (over 3 cm)	–	–	Long	Concentric	Olive	–	Viaduct	(Undulate)	–	Central Andes	Andine	<i>corani</i>
Terrestrial	Large (over 3 cm)	–	–	Short	Cyphelloid	Blue-green	–	Viaduct	Even	Present	Northern Andes	Forest	<i>gigantea</i>
Terrestrial	Large (over 3 cm)	–	–	Short	Concentric	Green	–	Viaduct	(Undulate)	–	Central Andes	Forest	<i>cuzcoensis</i>

Table 1 continued

Substrate	Lobe width	Soredia	Surface trichomes	Sutures	Hymenophore	Colour	Papillae	Cortex	Surface	Margin trichomes	Distribution	Habitat	Species
Terrestrial	Large (over 3 cm)	–	–	Short	Concentric	Brown	–	Viaduct	Undulate	–	Northern Andes	Andine	<i>paraciferrii</i>
Terrestrial	Large (over 3 cm)	–	–	Short	Concentric	Brown	–	Viaduct	(Undulate)	–	Northern Andes	Andine	<i>dalehana</i>
Terrestrial	Large (over 3 cm)	–	–	Short	–	Green	Present	Viaduct	Even	–	Central Andes	Andine	<i>pseudocorani</i>
Terrestrial	Large (over 3 cm)	–	–	–	Cyphelloid	Blue-green	–	Viaduct	Even	–	Central America	Forest	<i>gomeziana</i>
Terrestrial	Large (over 3 cm)	–	–	–	Cyphelloid	Green	–	Viaduct	Even	Present	Northern Andes	Forest	<i>rubrosanguinea</i>
Terrestrial	Large (over 3 cm)	–	–	–	Concentric	Brown	–	Viaduct	Undulate	–	Wide	Andine	<i>ciferrii</i>
Epiphytic	Small (to 1 cm)	Present	Present	–	–	Green	Present	Viaduct	Even	–	Northern Andes	Andine	<i>subdavicrinita</i>
Epiphytic	Small (to 1 cm)	Present	Present	–	–	Green	–	Viaduct	Even	–	Northern Andes	Andine	<i>davicrinita</i>
Epiphytic	Small (to 1 cm)	Present	–	Short	Cyphelloid	Green	Present	Viaduct	Rugose	–	Wide	Forest	<i>soredavidia</i>
Epiphytic	Small (to 1 cm)	Present	–	Short	–	Blue-green	Present	Collapsed	(Undulate)	–	Northern Andes	Andine	<i>rothesiorum</i>
Epiphytic	Small (to 1 cm)	Present	–	Short	–	Green	–	Compacted	Even	–	Central america	Andine	<i>minor</i>
Epiphytic	Small (to 1 cm)	Present	–	–	Concentric	Green	Present	Viaduct	(Undulate)	–	Mexico	Forest	<i>comaltepeca</i>
Epiphytic	Small (to 1 cm)	Present	–	–	–	Green	–	Compacted	Even	–	Central America	Andine	<i>paraminor</i>
Epiphytic	Small (to 1 cm)	Present	–	–	–	Green	–	Collapsed	Rugose	Present	Northern Andes	Andine	<i>minutula</i>
Epiphytic	Small (to 1 cm)	–	Present	–	Cyphelloid	Olive-brown	Present	Viaduct	(even)	Present	Northern Andes	Andine	<i>schizophylloides</i>
Epiphytic	Small (to 1 cm)	–	Present	–	–	Green	–	Viaduct	Rugose	Present	Northern Andes	Andine	<i>barbifera</i>
Epiphytic	Medium (1–3 cm)	Present	(Present)	Short	Adnate-confluent	Blue-green	Present	Viaduct	Even	(Present)	Northern Andes	Forest	<i>arcabucana</i>
Epiphytic	Medium (1–3 cm)	Present	–	Short	Adnate-confluent	Green	Present	Viaduct	Even	–	Northern Andes	Andine	<i>davidia</i>
Epiphytic	Medium (1–3 cm)	Present	–	Short	–	Olive	Present	Viaduct	Even	Present	Northern Andes	Andine	<i>inversa</i>
Epiphytic	Medium (1–3 cm)	Present	–	–	Adnate-confluent	Olive-brown	–	Viaduct	Even	–	Northern Andes	Andine	<i>crispoleslia</i>
Epiphytic	Medium (1–3 cm)	Present	–	–	–	Olive	Present	Viaduct	Even	–	Wide	Andine	<i>hawksworthiana</i>
Epiphytic	Medium (1–3 cm)	–	Present	Long	Adnate-confluent	Green	Present	Viaduct	(Undulate)	Present	Northern Andes	Forest	<i>garagoa</i>
Epiphytic	Medium (1–3 cm)	–	Present	Distinct	Cyphelloid	Olive-brown	Present	Viaduct	Even	Present	Central Andes	Andine	<i>hochesuordensis</i>
Epiphytic	Medium (1–3 cm)	–	Present	–	Concentric	Olive	–	Viaduct	Even	Present	Northern Andes	Andine	<i>byssoides</i>
Epiphytic	Medium (1–3 cm)	–	(Present)	Short	Concentric	Blue-green	–	Viaduct	(Undulate)	–	Central America	Forest	<i>smaragdina</i>
Epiphytic	Medium (1–3 cm)	–	(Present)	–	–	Green	Present	Collapsed	(Undulate)	Present	Northern Andes	Andine	<i>pastorum</i>
Epiphytic	Medium (1–3 cm)	–	–	Long	–	Green	–	Viaduct	(Undulate)	–	Brazil	Grassland	<i>itabaiana</i>
Epiphytic	Medium (1–3 cm)	–	–	Short	Subcyphelloid	Blue-green	Present	Viaduct	Even	–	Brazil	Forest	<i>caraana</i>
Epiphytic	Medium (1–3 cm)	–	–	Short	Adnate-confluent	Blue-green	–	Viaduct	(Undulate)	–	Northern Andes	Andine	<i>verjonensis</i>
Epiphytic	Medium (1–3 cm)	–	–	Short	Concentric	Blue-green	Present	Collapsed	(even)	–	Central America	Forest	<i>viliewoa</i>
Epiphytic	Medium (1–3 cm)	–	–	Short	Concentric	Green	Present	Viaduct	(Undulate)	–	Galapagos	Forest	<i>santacruzensis</i>
Epiphytic	Medium (1–3 cm)	–	–	Short	–	Green	Present	Collapsed	Even	–	Central America	Andine	<i>haledana</i>
Epiphytic	Medium (1–3 cm)	–	–	Short	–	Blue-green	–	Viaduct	Even	Present	Northern Andes	Forest	<i>fimbriata</i>
Epiphytic	Medium (1–3 cm)	–	–	–	Concentric	Blue-green	–	Compacted	(Undulate)	–	Northern Andes	Forest	<i>udebeceana</i>
Epiphytic	Medium (1–3 cm)	–	–	–	–	Blue-green	Present	Viaduct	Even	–	Central Andes	Forest	<i>boleslia</i>
Epiphytic	Medium (1–3 cm)	–	–	–	–	Blue-green	–	Viaduct	Undulate	–	Northern Andes	Forest	<i>canari</i>
Epiphytic	Medium (1–3 cm)	–	–	–	–	Green	Present	Compacted	(Undulate)	Present	Northern Andes	Andine	<i>corelleslia</i>
Epiphytic	Large (over 3 cm)	–	Present	Short	Subcyphelloid	Green	–	Viaduct	Even	–	Central America	Andine	<i>barbulata</i>

Table 1 continued

Substrate	Lobe width	Soredia	Surface trichomes	Sutures	Hymenophore	Colour	Papillae	Cortex	Surface	Margin trichomes	Distribution	Habitat	Species
Epiphytic	Large (over 3 cm)	–	Present	Short	Concentric	Green	–	Viaduct	Even	–	Central Andes	Forest	<i>maxima</i>
Epiphytic	Large (over 3 cm)	–	Present	–	Concentric	Green	–	Viaduct	Even	Present	Northern Andes	Andine	<i>arachnoidea</i>
Epiphytic	Large (over 3 cm)	–	(Present)	Short	Concentric	Green	–	Collapsed	(Undulate)	Present	Central Andes	Forest	<i>aspera</i>
Epiphytic	Large (over 3 cm)	–	–	Long	Adnate-confluent	Blue-green	Present	Viaduct	(Undulate)	–	Central America	Forest	<i>hymenocarpa</i>
Epiphytic	Large (over 3 cm)	–	–	Long	Concentric	Blue-green	Present	Viaduct	(Undulate)	–	Caribbean	Forest	<i>yukiboa</i>
Epiphytic	Large (over 3 cm)	–	–	Long	–	Blue-green	–	Compacted	Undulate	–	Northern Andes	Forest	<i>suturifera</i>
Epiphytic	Large (over 3 cm)	–	–	Short	Concentric	Green	Present	Viaduct	Undulate	Present	Northern Andes	Forest	<i>setosa</i>
Epiphytic	Large (over 3 cm)	–	–	Short	Concentric	Green	Present	Viaduct	(Undulate)	–	Northern Andes	Forest	<i>putumayensis</i>
Epiphytic	Large (over 3 cm)	–	–	Short	Concentric	Green	Present	Viaduct	Even	–	Central America	Forest	<i>arborescens</i>
Epiphytic	Large (over 3 cm)	–	–	Short	–	Green	–	Collapsed	(Undulate)	–	Northern Andes	Andine	<i>pikynasa</i>
Epiphytic	Large (over 3 cm)	–	–	–	Cyphelloid	Blue-green	–	Viaduct	Pitted	Present	Northern Andes	Forest	<i>cyphellifera</i>

Fig. 3 **A–C** *Cora accipiter* (**A** holotype; **B** Lücking & Moncada 34008; **C** Lücking & Moncada 39435). **D** *C. arachnoidea* (Lücking & Moncada 33382b). **E–G**. *C. appianata* (E, Lücking & Moncada 33533; **F–G**, holotype, in **F** dry, in **G** rewetted, in **F** with inlet showing section through thallus with compacted upper cortex). **H** *C. archnodavidea* (holotype). **I–J** *C. arborescens* (isotype; in **I** rewetted, in **J** section through lower medulla with papilliform hyphae) **K–M** *C. araucana* (isotype; in **K** rewetted, in **L** dried lobe with surface trichomes; in **M** underside with hymenophore). **N**, **O**. *C. aurica* (**N** holotype; **O** paratype, with laterally protruding hymenophore). Scale = 10 mm, in **F** (inlet) = 100 µm, in **J** = 10 µm

cream-coloured when fresh, becoming light yellowish grey in the herbarium. Thallus in section 400–500 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–40 µm thick layer of rather densely packed, more or less periclinal, 4–6 µm thick hyphae supported by a 70–100 µm high ‘medullary’ layer of spaced groups of antichlinal, 4–6 µm thick hyphae, upper layer with emerging setae formed by agglutinate hyphae, setae 200–400 µm long and 30–40 µm thick at the base; photobiont layer 100–200 µm thick, orange-brown above, aeruginous-green below; medulla 100–150 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore corticioid, developed as irregular to elongate, partly anastomosing, resupinate patches forming diffusely concentric lines, patches 0.5–1(–2) mm long and 1–5 mm broad, with pale yellowish brown, smooth surface and indistinct, shortly pilose margins; hymenophore in section 60–80 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 5–7 µm; basidia 25–35 × 5–7 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: La Calera, paramo of Chingaza; 04°44'N, 73°52'W, 3600 m; 7 November 2011, Lücking & Moncada 34011 (ANDES **holotype**; **B**, **F** **isotypes**), 34008 (**F** **paratype**). COLOMBIA. Cundinamarca: Choachí, Matarredonda Ecological Park, El Verjón; 04°33'N, 74°00'W, 3220 m; 23 January 2011, Moncada 4602 (**F**, UDBC **paratypes**). Guasca, paramo of Guasca; 04°51'N, 73°49'W, 3350 m; 18 August 2011, Lücking & Moncada 33310 (**F**, UDBC **paratypes**). La Calera, paramo of Chingaza; 04°44'N, 73°50'W, 3430 m; 13 April 2011, Moncada 4655 (**B**, UDBC **paratypes**). Villa Pinzón, paramo of Guacheneque; 05°13'N, 73°32'W, 3335 m; 15 May 2012, Moncada & Suárez 5400, 5400a, 5412, 5473 (**F**, UDBC **paratypes**). Distrito Capital: Bogotá, paramo of Sumapaz; 04°17'N, 74°13'W, 3730 m; 3 December 2011, Lücking & Moncada 34113, 34117a (**B**, **F**, UDBC **paratypes**); *ibid.*; 13 August 2015, Lücking & Moncada 39435, 39439, 39440, 39443, 39444, 39445, 39449 (**B**, **JB** **paratypes**). Nariño: Puertes, paramo of Cerro Negro; 00°52'N, 77°27'W, 3350 m; 26 October 2013, Moncada & Lücking 7798, 7806 (**B**, UDBC



paratypes). VENEZUELA. Mérida: Sierra Nevada National Park; 08°47'N, 70°49'W, 3630 m; 6 December 2009, Hernández 1780 (VEN **paratype**).

Distribution and ecology: Wet paramo regions of the northern Andes in South America, growing (sub-)epiphytically at the base or on lower stems of paramo shrubs or near the ground over grasses and other herbaceous plants.

Notes: This new species of *Cora* is recognized by its rupturing lateral sutures, which give the lobes a characteristic, fan- to wing-shaped appearance, in combination with a concentrically arachnoid-tomentose upper surface. Its fresh colour varies between a light olive and olive-brown. Phylogenetically, *C. accipiter* is related to *C. cyphellifera* Dal Forno, Bungartz & Lücking and *C. arachnoidea* J.E. Hernández & Lücking, within which the material was included previously (Lücking et al. 2013a), but the expanded data set (Lücking et al. 2014b, this paper) separates the two taxa. *Cora arachnoidea* s.str. also has a distinctly imbricate thallus consisting of regularly rounded, lighter green-grey lobes (Fig. 3D). At the paramo of Sumapaz, *C. accipiter* was the only species observed to show very regular bite marks by an unknown animal (Fig. 3C), suggesting that this species may have a particular chemical composition not detectable using TLC.

***Cora applanata* Moncada, Soto-Medina & Lücking spec. nov.**

Index Fungorum: 552382; **Faces Of Fungi:** 02537; Fig. 3E–G

Etymology: The epithet refers to the strongly applanate thallus growing completely adnate to the ground.

Holotype: Lücking & Moncada 33530 (UDBC).

ITS barcoding sequence: KJ780473 (holotype), KJ780392, KJ780398, KJ780483, KJ780491, KJ780622, KJ780627, KJ780635, KJ780671, KX772490, KX772491, KX772506, KX772509, KX772574, KX772577, KX772582, KX772584 (paratypes).

Diagnosis: A mid-sized, terricolous *Cora* growing directly on bare soil, with frequently branched, completely adnate lobes that are olive-green to olive-grey when fresh and upon drying rapidly show a distinct concentric colour zonation that is maintained in the herbarium.

Thallus terricolous, growing directly on bare soil, foliose, up to 10 cm across but numerous thalli often covering large areas, composed of 3–7 semicircular, adjacent lobes; individual lobes 1–2 cm wide and 1–2 cm long, starting out as perfectly circular patches but soon becoming moderately to frequently branched, often becoming eroded at the tips, without distinct branching sutures, surface olive-green to dark olive-grey when fresh, with rapidly appearing, distinct concentric colour zonation upon drying, with thin but distinct, involute, whitish margins, retaining the concentric colour pattern exactly in the herbarium.

Upper surface very shallowly undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous to papillose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla) to somewhat warty, grey when fresh, becoming white-grey in the herbarium. Thallus in section 150–200 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex compacted, formed by a 10–20 µm thick layer of loosely to densely packed, irregularly arranged, 4–5 µm thick hyphae; photobiont layer 70–130 µm thick, olive-green above, aeruginous-green below; medulla 30–50 µm thick, hydrophobic; clamp connections absent, papilliform hyphae absent. Hymenophore developed as rounded to irregular to elongate, often anastomosing, resupinate patches with rounded ends forming diffusely concentric lines, patches 0.3–0.5 mm long and 0.3–1 mm broad, with cream-coloured, smooth surface and indistinct margins; hymenophore in section 80–100 µm thick, supported by a thickened medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–25 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Valle del Cauca: Cali, El Topacio; 03°19'N, 76°40'W, 2400 m; 9 August 2011, Lücking & Moncada 33530 (UDBC **holotype**; B, F **isotype**); *ibid.*, Lücking & Moncada 33533, 33534 (B, F, UDBC **paratypes**). COLOMBIA. Boyacá. Arcabuco, El Chircal; 05°44'N, 73°29'W, 2490 m; 28 April 2015, Gonzáles et al. 1077 (B, UDBC **paratypes**). Arcabuco, El Cometa, 05°44'N, 73°30'W, 2480 m; 28 April 2015, Moncada & Rodríguez 9113 (B, UDBC **paratypes**). Arcabuco, Vereda Monte Suárez towards Monte Verde; 05°44'N, 73°29'W, 2530 m; 27 April 2015, Reyes et al. 519, 567 (B, UDBC **paratypes**). Gachantivá, Vereda Centro towards Cerro Patiño; 05°45'N, 73°33'W, 2420 m; 11 May 2013, Moncada et al. 6624 (B, UDBC **paratypes**). Distrito Capital: Bogotá, paramo of Sumapaz, near Chisaca Lagoon; 04°17'N, 74° 02'W, 3720 m; 20 November 2012, Moncada et al. 6424b, c (B, UDBC **paratypes**). Valle del Cauca. Dagua, road towards Cerro de San Antonio (Horqueta); 03°30'N, 76°37'W, 1950 m; 8 April 2014, Moncada & Peláez 8553 (B, UDBC **paratypes**). Risaralda: Santuario, Planes de San Rafael, near Tatamá Natural National Park; 05°08'N, 76°01'W, 2249 m; 12 January 2011, Coca et al. 948 (B, FAUC, **paratypes**). ECUADOR. Carchi: Cerro Verde; May 1999, Cerón 38530 (B, F, QCNE **paratypes**). Azuay: Camilo Ponce Enriquez, Concesión Minera IMC; 02°48'S, 79°22'W, 300 m; 12 December 2009, Nugra 863 (B, F, HA **paratypes**). Imbabura: Cotacachi, W of Otavalo and Ibarra along road Cotacachi-Intag; 00°23'N, 78°28'W, 2067 m; 25 June 2012, Dal Forno 1789, 1790 (GMUF, QCNE **paratypes**). Pinchincha: San Miguel

de Los Bancos, entrance road to Yellow House Farm near Mindo; 00°03'N, 78°46'W, 1316 m; 3 July 2012, Dal Forno 1934 (GMUF, QCNE **paratypes**).

Distribution and ecology: Apparently a widespread northern Andean species, often found extensively in the tropical montane zone on bare soil along open road banks and on land slides in exposed conditions. After wetting, the thallus dries out very quickly, resulting in a distinct colour zonation visible even under humid atmospheric conditions.

Notes: This is one of several, morphologically and ecologically similar species in the *Cora reticulifera* clade (Lücking et al. 2014b). Most species in this clade grow directly on bare soil, with completely adnate lobes and with a well-developed, often anastomosing to reticulate hymenophore. The species in this clade are difficult to distinguish morphologically, but exhibit rather distinct distribution patterns: *C. applanata* in the northern Andes, a yet undescribed species in the Central Andes (Bolivia), and *C. reticulifera* in southeastern Brazil. This clade is typical of tropical (sub-)montane areas, occurring at lower altitudes than most other *Cora* species.

***Cora arachnodavidea* Moncada, Dal Forno & Lücking spec. nov.**

Index Fungorum: 552383; *Faces Of Fungi*: 02538; Fig. 3H

Etymology: The epithet combines a reference to the arachnoid lobe surface with David Hawksworth's first name. The name David is based on the Hebrew name Dawid, which was probably derived from the Hebrew דָּוִד (*dwd*), which means "beloved".

Holotype: Lücking & Moncada 33326 (UDBC).

ITS barcoding sequence: KJ780477 (holotype), KJ780492 (paratype).

Diagnosis: A mid-sized, terrestrial *Cora* with densely arachnoid lobe surface and pilose margins.

Thallus terrestrial on the ground between bryophytes or at the base of plants, foliose, up to 7 cm across, composed of 3–5 semicircular, adjacent lobes; individual lobes 1–3 cm wide and 1–3 cm long, sparsely branched, without distinct, radial branching sutures, surface olive-brown to olive-grey when fresh, whitish along the arachnoid zones, with some concentric colour zonation, with distinct, involute, whitish margins, becoming light grey in the herbarium. Upper even when fresh, rugose when dry, broadly arachnoid; involute margins distinctly pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light grey in the herbarium. Thallus in section 350–450 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 30–50 µm thick layer of loosely packed, irregularly arranged, 4–6 µm thick hyphae supported by a 100–150 µm high 'medullary'

layer of spaced, irregularly arranged to more or less anticlinal, 4–6 µm thick hyphae, upper layer with emerging setae formed by tufts of agglutinate hyphae, setae 200–300 µm long and 30–50 µm broad at the base; photobiont layer 100–200 µm thick, orange-brown above, olive-green below; medulla 70–100 µm thick; clamp connections absent but lower medulla with emerging, branched to coralloid hyphae 3–5 µm thick. Hymenophore cyphelloid, developed as rounded to irregular, sessile, concave to urceolate patches 3–5 mm diam., with cream-coloured to pale orange-brown, smooth surface and felty, involute margins; hymenophore in section 200–250 µm thick, supported by a thickened medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 40–50 × 5–7 µm, partly branched; basidia 25–35 × 5–7 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: Guasca, paramo of Guasca; 04°51'N, 73°49'W, 3220 m; 18 August 2011, Lücking & Moncada 33326 (UDBC **holotype**; B **isotype**), 33382b (B, UDBC **paratypes**).

Distribution and ecology: Known only from the paramo of Guasca in Colombia, near the capital Bogotá, growing on the ground between plants and bryophytes in somewhat sheltered places.

Notes: This species is most similar in morphology and ecology to *Cora dewisanti* (see below), but differs in the much more densely arachnoid-pilose lobe surface. The two species are not closely related, although they belong in the same larger clade (Lücking et al. 2014b). Also similar is *C. arachnoidea*, which differs in the epiphytic habit and the lighter, grey-green thallus. *Cora arachnodavidea* is closely related to the glabrous *C. cyphellifera* Dal Forno, Bungartz & Lücking (Lücking et al. 2013a) and shares the cyphelloid hymenophore with the latter, and both species are unsupported sister to *C. arachnoidea* (Lücking et al. 2014b).

***Cora arborescens* Dal Forno, Chaves & Lücking spec. nov.**

Index Fungorum: 552384; *Faces Of Fungi*: 02539; Fig. 3I, J

Etymology: The epithet refers to the epiphytic growth on trees.

Holotype: Dal Forno 1705 (CR).

ITS barcoding sequence: KJ780599 (holotype).

Diagnosis: A medium-sized, epiphytic, subandine forest species with emerald-green lobes with even surface.

Thallus epiphytic, foliose, up to 5 cm across, composed of 2–5 semicircular, subimbricate lobes; individual lobes 1.5–3(–4) cm wide and 2–2.5 cm long, sparsely branched and with short, radial branching sutures, surface emerald-green when fresh, with some concentric colour zonation, with thin, involute, green margins, becoming uniformly

light grey in the herbarium. Upper surface even when fresh, slightly rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), light grey when fresh and in the herbarium. Thallus in section 240–330 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–25 µm thick layer of densely packed, periclinal, 2–4 µm thick hyphae supported by a 40–100 µm high ‘medullary’ layer of spaced groups of more densely packed, anticlinal, 3–6 µm thick hyphae; photobiont layer 80–155 µm thick, aeruginous-green; medulla 45–90 µm thick; clamp connections absent but lower medullary hyphae with numerous papilliform, unbranched to branched hyphae 3–6 µm thick. Hymenophore developed as diffuse, concentric, resupinate, irregularly rounded to elongate patches, up to 0.5 mm long and 5 mm broad, with pale yellow-orange, smooth surface and smooth to slightly felty, involute margins; hymenophore in section 80–115 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 15–25 × 4–6 µm; basidia 20–30 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COSTA RICA. Cartago: Tapantí National Park opposite Cerro de la Muerte; 09°34'N, 83°45'W, 3300–3400 m; 21 May 2012, Dal Forno 1705 (CR **holotype**; GMUF **isotype**).

Distribution and ecology: Known only from the type locality near Cerro de la Muerte in Costa Rica, growing epiphytically on tree branches and twigs in a subandine forest.

Notes: *Cora arborescens* is medium-sized, epiphytic subandine forest species, similar in morphology to several others growing in a similar habitat. *Cora canari* from Ecuador, *C. smaragdina* from Costa Rica, and *C. udebeceana* and *C. verjonensis* from Colombia (see below) differ in their shallowly to distinctly undulate lobes and lack of papillae; *C. udebeceana* also has a compacted cortex. *Cora boleslia* from Bolivia and *C. viliewoa* from Costa Rica, Colombia, and Ecuador (see below), agree with *C. arborescens* in the even lobe surface and presence of papillae, but have a thinner thallus and *C. viliewoa* also differs in the collapsed cortex. *Cora haledana* can be distinguished by the collapsed-compacted cortex. Remarkably, these species are not closely related.

Cora arcabucana Moncada, C. Rodríguez & Lücking **spec. nov.**

Index Fungorum: 552385; **Faces Of Fungi:** 02540; **Fig.** 3K–M

Etymology: The epithet refers to the type locality in the municipality of Arcabuco in Boyacá, Colombia.

Holotype: Moncada & Rodríguez 9081 (UDBC).

ITS barcoding sequence: KX772585 (holotype), KX772583, KX772586, KX772587 (paratypes).

Diagnosis: A small to medium-sized, epiphytic *Cora* with aeruginous-green lobes when fresh, with scattered surface hairs and scattered marginal soredia, as well as an adnate-confluent, emarginate hymenophore.

Thallus epiphytic on branches of shrubs and trees, usually over bryophytes, foliose, up to 3 cm across, composed of 3–7 semicircular, adjacent to subimbricate lobes; individual lobes 0.5–2 cm wide and 0.5–2 cm long, moderately to frequently branched, forming various terminal lobules, with short, radial branching sutures, surface aeruginous-green when fresh, without concentric colour zonation, with thin, involute, greenish-grey margins, becoming white-grey in the herbarium. Upper surface even when fresh, rugose when dry, when young with concentric bands of scattered hairs, when mature with few, scattered hairs, otherwise glabrous; involute margins glabrous to sparsely and thinly pilose, forming scattered soredia; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), greenish-grey when fresh, becoming light grey in the herbarium. Thallus in section 170–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 70–100 µm thick layer of loosely packed, more or less periclinal, 4–6 µm thick hyphae supported by a 80–100 µm high ‘medullary’ layer of spaced groups of more densely packed, anticlinal, 4–6 µm thick hyphae; photobiont layer 50–100 µm thick, aeruginous-green; medulla 30–50 µm thick, strongly hydrophobic; clamp connections absent but lowermost medullary hyphae with numerous, branched to coralloid, papilliform hyphae 2–3 µm thick. Hymenophore corticioid, developed as rounded to irregular, completely adnate and emarginate patches soon becoming confluent and covering large areas of the lower surface, patches at first 0.3–0.5 mm long and 0.3–0.5 mm broad, when confluent forming concentric patches up to 2 × 10 mm diam., with cream-white, smooth surface; hymenophore in section 20–30 µm thick, above a thickened, supporting medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 5–6 µm; basidia (few observed) 25–35 × 5–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Boyacá. Arcabuco, El Chircal; 05°44'N, 73°29'W, 2490 m; 28 April 2015, Moncada & Rodríguez 9081 (UDBC **holotype**; B **isotype**), 9043 (B, UDBC **paratypes**). Boyacá: Arcabuco, El Chircal; 05°44'N, 73°29'W, 2490 m; 28 April 2015, Castro et al. 251 (B, UDBC **paratypes**), *ibid.*, El Cometa, 05°44'N, 73°30'W, 2480 m; 28 April 2015, Moncada & Rodríguez 9119 (B, UDBC **paratypes**).

Distribution and ecology: Montane rain forest between 2500 and 3000 m of the northern Andes (Colombia),

growing epiphytically on twigs of shrubs and small trees in shaded to semi-exposed conditions.

Notes: This species is very closely related to *Cora davidia* (see below; Lücking et al. 2014b), with which it shares the epiphytic growth habit and the adnate-confluent hymenophore, as well as the numerous papillae developed on the lower surface. After careful consideration of the observed differences, in combination with the emergent phylogenetic position on a well-supported subclade, we concluded that the material warrants recognition as a separate species. The fresh colour is aeruginous-green, rather than olive-green, the soredia are sparse, the surface is thinly pilose, and the papillae are narrower and more branched in *C. arcabucana*; in addition, the habitat ecology is different, with *C. davidia* being known only from paramo whereas *C. arcabucana* is a montane forest species. Another similar, closely related and more or less cryptic species is *C. garagoa* (see below), which is slightly larger and lacks soredia.

***Cora aturucoa* Lücking, Moncada & C. Vargas spec. nov.**

Index Fungorum: 552386; *Faces Of Fungi*: 02541; Fig. 3N, O

Etymology: The epithet is derived from the acronym of the Asociación de Turismo Rural Comunitario Bogotá D.C. Ciudad Bolívar, which administers the trail where the new species was found and which is the first such association founded in Bogotá.

Holotype: Lücking & Moncada 39506 (JBB).

ITS barcoding sequences: KX772607 (holotype), KX772615 (paratype).

Diagnosis: A rather large, saxicolous *Cora* with green-grey, concentrically undulate lobes and resupinate, marginally protruding hymenophore.

Thallus saxicolous, growing directly on the rock surface together with other lichens in exposed microsites, foliose, up to 20 cm across, composed of 5–10 semicircular, adjacent to subimbricate lobes; individual lobes 3–6 cm wide and 2–4 cm long, sparsely to moderately branched, without radial branching sutures, surface rather dark green-grey to olive-green when fresh, with slight concentric colour zonation, with distinct, involute, whitish margins, becoming yellowish grey in the herbarium and with a weak reddish tinge upon rewetting, especially along the border and the hymenophore. Upper surface narrowly undulate when fresh, shallowly undulate when dry, glabrous; involute margins finely but distinctly pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming pale yellowish grey in the herbarium. Thallus in section 250–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–40 µm thick layer of densely packed, more or less periclinal, 4–6 µm

thick hyphae supported by a 50–70 µm high ‘medullary’ layer of spaced groups of anticlinal, 4–6 µm thick hyphae, separated from the photobiont layer by a layer of densely packed, anticlinal, yellowish hyphae; photobiont layer 70–120 µm thick, aeruginous-green; medulla 100–130 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore corticioid-cyphelloid, developed as initially rounded but soon confluent (especially towards the margin), resupinate patches, irregularly arranged and often protruding beneath the lobe margins, forming a conspicuous border, patches 2–5 mm diam. but up to several cm broad when confluent, with cream-coloured, smooth surface and felty, involute margins; hymenophore in section 90–120 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–35 × 4–5 µm; basidia 25–35 × 4–5 µm, 4-sterigmate; basidiospores not observed. Chemistry: Producing a reddish pigment upon rewetting.

Material examined: COLOMBIA. Distrito Capital: Bogotá, corregimiento of Pasquilla, sendero Peña Blanca along Río Tunjuelo; 04°26'N, 74°08'W, 2850 m; 14 August 2015, Lücking & Moncada 39506 (JBB **holotype**; B **isotype**); *ibid.*, Lücking & Moncada 39508 (B, JBB **paratypes**).

Distribution and ecology: The species was found on an open rock surface (boulder) along a stream in the high andean forest zone, growing with other lichens such as *Cladonia* directly on rock.

Notes: *Cora aturucoa* is closely related to *C. elephas* (see below) and shares with the latter and other species in this clade the substrate ecology and particular pigment chemistry upon rewetting of herbarium material; however, its fresh colour is more greenish, the lobe surface is distinctly undulate, the lobe margins and the thallus are thinner, and the hymenophore differs in forming large, confluent, marginally protruding patches.

***Cora auriculeslia* Moncada, Yáñez-Ayabaca & Lücking spec. nov.**

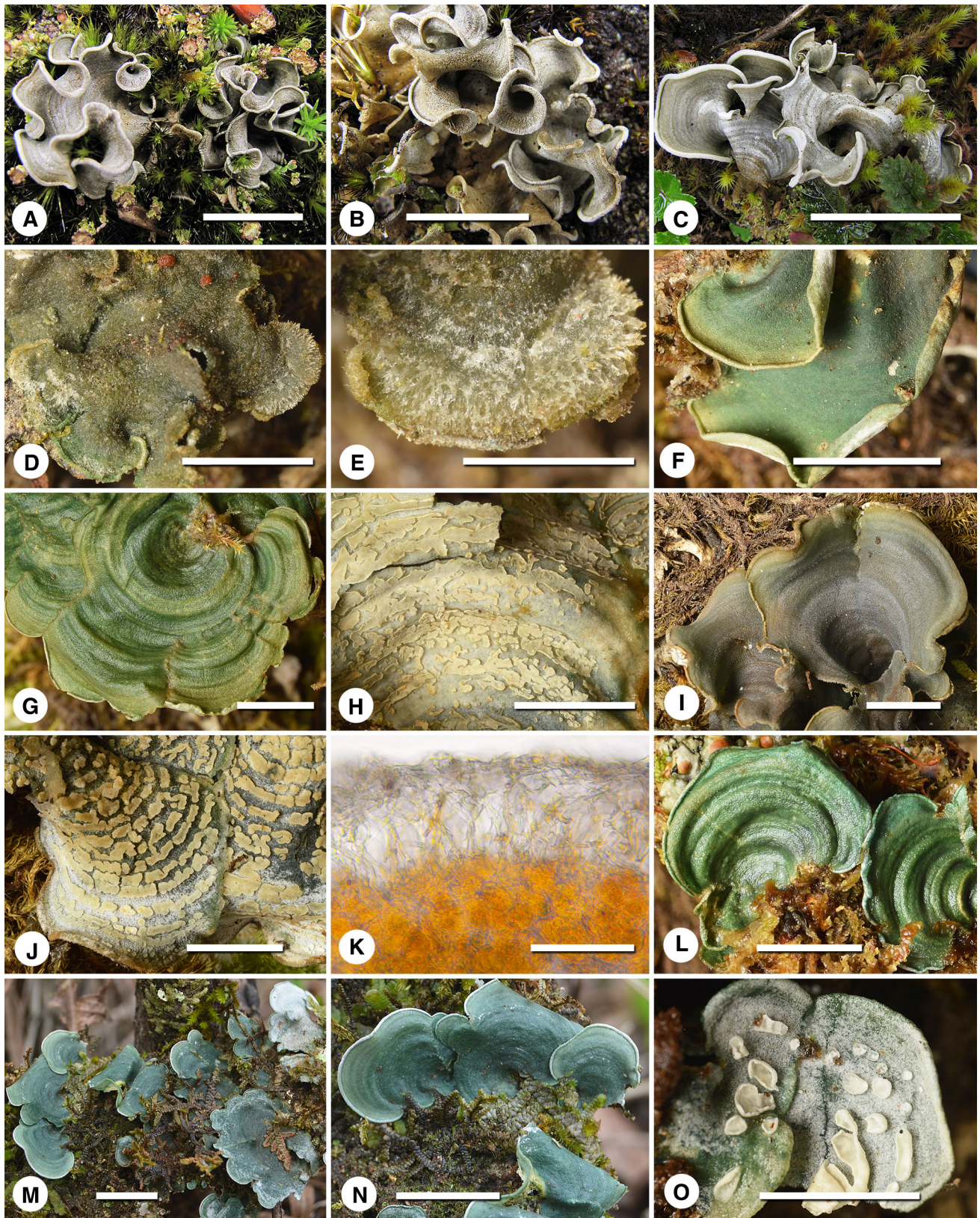
Index Fungorum: 552387; *Faces Of Fungi*: 02542; Fig. 4A–C

Etymology: The epithet is a combination of a reference to the ear-shaped lobes of this species and David’s second name, Leslie, originally a Scottish surname based on a Scottish place name, probably derived from Gaelic *leas celyn* (“garden of holly”). Leslie has been used as a given name since the 19th century.

Holotype: Lücking 32302 (QCNE).

ITS barcoding sequence: KJ780378 (holotype), KJ780376, KJ780377, KJ780379 (paratypes).

Diagnosis: A small, terrestrial *Cora* growing close to the ground, with strongly bent, ear-shaped lobes, with light



◀ **Fig. 4** **A–C** *Cora auriculeslia* (**A** Lücking 32303; **B** holotype; **C** Lücking 32300). **D–E** *C. barbifera* (isotype). **F** *C. boleslia* (isotype, rewetted). **G, H** *C. aspera* (isotype, in **G** rewetted, in **H** underside with hymenophore). **I, J** *C. caliginosa* (Farfan s.n., in **I** rewetted, in **J** underside with hymenophore). **K** *C. campestris* (isotype, section through upper thallus portion showing viaduct-shaped cortex and orange-brown pigmented photobiont layer). **L** *C. canari* (isotype, rewetted). **M–O** *C. caraana* (**M, N**, holotype; **O** isotype, underside with hymenophore). Scale = 10 mm, in **E** = 5 mm, in **K** = 100 µm

olive-grey colour when fresh and rather thick, light grey margins.

Thallus terricolous, growing close to the ground between mosses, macrosquamulose, up to 3 cm across, composed of 5–15 semicircular, strongly bent, subimbricate lobes; individual lobes 0.5–1 cm wide and 0.3–0.7 cm long, sparsely branched, without radial branching sutures, surface light olive-grey when fresh, with slight concentric colour zonation, with distinct, involute, light grey margins, becoming (light) grey in the herbarium. Upper surface rugose when fresh and dry, glabrous; involute margins rough; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), grey when fresh and in the herbarium. Thallus in section 400–500 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex compacted, formed by a 20–30 µm thick layer of rather densely packed, irregularly arranged, 3–4 µm thick hyphae; photobiont layer 100–150 µm thick, orange-brown above, aeruginous-green below; medulla 200–250 µm thick, below the photobiont layer compacted and hydrophobic, towards the underside loose; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: ECUADOR. Napo: Papallacta, paramo of La Virgen; 00°23'N, 78°09'W, 3300 m; 4 July 2010, Lücking 32302 (QCNE **holotype**; **B, F** **isotypes**), 32300 (**F**, QCNE **paratypes**), 32301, 32303 (**B, F**, QCNE **paratypes**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes, thus far only known from the type locality near Quito in Ecuador, growing terricolous near the ground in shaded microsites.

Notes: The material here recognized as a new species was first considered to belong to *Cora squamiformis* Wilk, Lücking & Yáñez-Ayabaca, with the type material from Bolivia, and the material now separated was erroneously depicted as from Colombia (Lücking et al. 2013a: 17, Fig. 8). *Cora auriculeslia* is a closely related sister species of *C. squamiformis*, indicating that it represents a recently evolved species (Lücking et al. 2014b), both share the thin, compacted cortex. *Cora auriculeslia* differs from the latter in the more erect, strongly bent, ear-shaped lobes with thinner margins, as well as the light olive-grey colour when fresh (brown in *C. squamiformis*). The ecology of the two

species is also different, with *C. squamiformis* found in the drier and more extreme Central Andean puna regions at much higher altitudes, whereas *C. auriculeslia* appears to be a wet paramo species. The *C. squamiformis* clade contains a third, closely related species (Lücking et al. 2014b), *C. caliginosa* (see below), which is morphologically and ecologically quite distinct, forming much larger, dark olive-grey lobes and being found in montane rain forest.

***Cora barbifera* Moncada, Patiño & Lücking spec. nov.**

Index Fungorum: 552388; *Faces Of Fungi*: 02543; Fig. 4D, E

Etymology: The epithet refers to the distinct setae of the lobe surface, reminiscent of a beard. The striking resemblance to the lower portion of David's goatee is entirely coincidental and unintended.

Holotype: Moncada & Lücking 7865 (UDBC).

ITS barcoding sequence: KX772682 (holotype).

Diagnosis: A small, epiphytic *Cora* with olive-green lobes with densely setose surface.

Thallus epiphytic on paramo shrubs, macrosquamulose, up to 2 cm across, composed of 3–5 semicircular, adjacent to subimbricate lobes; individual lobes 0.5–1 cm wide and 0.5–1 cm long, adnate to ascending, moderately to frequently branched, without distinct, radial branching sutures, surface olive-green when fresh, without concentric colour zonation but mottled with whitish areas, with distinct, involute, grey to light olive margins, becoming brownish grey in the herbarium. Upper surface uneven to granulose when fresh, rugose when dry, with concentric bands of densely arranged, outwardly oriented setae; involute margins granulose but not distinctly sorediate, thinly pilose in parts; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light grey in the herbarium. Thallus in section 200–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged, 4–6 µm thick hyphae supported by a 50–100 µm high 'medullary' layer of spaced, irregularly arranged to more or less anticlinal, 4–6 µm thick hyphae, upper layer with emerging setae formed by tufts of agglutinate hyphae, setae 70–100 µm long and 15–20 µm broad at the base; photobiont layer 50–100 µm thick, aeruginous-green; medulla 30–70 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Nariño: Puerres, paramo of Cerro Negro; 00°52'N, 77°27'W, 3350 m; 26 October 2013, Moncada & Lücking 7865 (UDBC **holotype**; **B** **isotype**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes, thus far only known from the type

locality near Pasto in southern Colombia, growing epiphytically on paramo shrubs.

Notes: *Cora barbifera* is the only small, epiphytic species known so far to produce distinct surface trichomes but lacking soredia. It is related to the even more distinctly setose-strigose *C. hirsuta* and *C. schizophylloides* (see below; Fig. 2; Online Supplement D), which differ chiefly in producing medullary papillae.

***Cora boleslia* Lücking, E. Morales & Dal Forno spec. nov.**

Index Fungorum: 552389; *Faces Of Fungi:* 02544; Fig. 4F

Etymology: The epithet combines the type locality in Bolivia with David's second name, Leslie.

Holotype: Lücking 29128 (HCUCB).

ITS barcoding sequence: KF443230, KJ802416 (holotype; KJ802416 from 454 pyrosequencing).

Diagnosis: A small to mid-sized, epiphytic *Cora* with uniformly aeruginous-green lobes and even surface, lacking concentric undulations.

Thallus epiphytic on twigs of trees, foliose, up to 5 cm across, composed of 2–5 semicircular, adjacent lobes; individual lobes 1–2 cm wide and 0.7–1.5 cm long, unbranched, without radial branching sutures, surface aeruginous-green when fresh, without concentric colour zonation, with thin, involute, green-grey margins, becoming grey in the herbarium. Upper surface even when fresh, rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming grey in the herbarium. Thallus in section 150–200 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae supported by a 30–50 µm high 'medullary' layer of spaced groups of irregularly arranged to anticlinal, 4–6 µm thick hyphae; photobiont layer 50–80 µm thick, aeruginous; medulla 20–50 µm thick, hydrophobic; clamp connections absent but lowermost medullary hyphae with numerous, papilliform to coralloid hyphae 2–3 µm thick. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: BOLIVIA. Cochabamba: Chapare, Incachaca; 17°14'S, 65°49'W, 2200 m; 7 July 2009, Lücking 29128 (HCUCB **holotype**; B, F **isotypes**).

Distribution and ecology: Central Andes in Bolivia, in montane rain forest, growing epiphytically on twigs of trees in partially shaded conditions.

Notes: *Cora boleslia* is a rather non-descript, epiphytic species known from a single, small collection only; hence, its entire morphological variation cannot be assessed with certainty. It shares with several other species the aeruginous-green (to emerald-green) colour when fresh, but

differs from those taxa by the even surface lacking concentric undulations. The species is phylogenetically related to *C. aspera* (Fig. 4G, H) and was included in a broader concept of that species (Lücking et al. 2013a), but represents a separate clade (Lücking et al. 2014b). The fact that practically all material of *Cora* collected in Bolivia represents phylogenetically distinct species underlines the importance of the formation of the Andes in the geographical diversification of this genus (Lücking et al. 2014b).

***Cora caliginosa* Holgado, Rivas Plata & Perlmutter spec. nov.**

Index Fungorum: 552390; *Faces Of Fungi:* 02545; Fig. 4I, J

Etymology: The epithet refers to the dark colour when fresh (Latin: *caliginosus* = dull, somber, cloudy). In spite of the many fungal and lichen species described by David, none bears the epithet *caliginosus/a/um*, except for the recombined *Xanthoparmelia caliginosa* (Essl.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch (Blanco et al. 2004).

Holotype: Jihuallanca et al. s.n. (CUZ).

ITS barcoding sequence: KJ780365, KJ780366, KJ802414 (holotype; KJ802414 from 454 pyrosequencing).

Diagnosis: A mid-sized, terrestrial *Cora* growing over bryophytes, with dark olive-grey lobes when fresh, with often eroded margins and strongly confluent hymenophore covering large parts of the underside.

Thallus terrestrial over bryophytes, foliose, up to 10 cm across, composed of 5–10 semicircular but sometimes irregular (due to erosion), adjacent to subimbricate lobes; individual lobes 1–3 cm wide and 1–5 cm long, moderately branched, with short, radial branching sutures, surface dark olive-grey when fresh, without concentric colour zonation, with thin, involute, light olive margins, becoming white-grey with cream-coloured margins in the herbarium. Upper surface even to very shallowly concentrically undulate when fresh, rugose when dry, glabrous or with indistinct, concentric bands of short, whitish hairs; involute margins glabrous but sometimes eroded; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), olive-grey when fresh, becoming white-grey in the herbarium. Thallus in section 400–450 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 30–50 µm thick layer of loosely packed, irregularly arranged to more or less periclinal, 4–6 µm thick hyphae supported by a 50–70 µm high 'medullary' layer of spaced groups of irregularly arranged to anticlinal, 4–6 µm thick hyphae; photobiont layer 150–220 µm thick, orange-brown above, aeruginous-green below; medulla 70–100 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as irregular to linear, resupinate

patches forming concentric lines, becoming confluent, patches at first 0.5–1.5 mm long and 1–5 mm broad but when confluent up to 5 mm broad and 15 mm long or eventually covering large areas of the underside, with cream-coloured to pale yellowish, smooth surface and indistinct, slightly involute, rough to minutely pilose margins; hymenophore in section 80–120 μm thick, supported by a massive medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 $\times$ 5–7 μm ; basidia 25–35 $\times$ 5–5 μm , 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: PERU. Cuzco: Piscacucho; 13°10'S, 72°21'W, 3500 m; 4 August 2009, Jihuallanca et al. s.n. (CUZ **holotype**; B **isotype**); *ibid.*, Farfan et al. s.n. (B, CUZ **paratypes**).

Distribution and ecology: Only known from the type locality near Machu Picchu, growing on the ground in the surroundings of a highly disturbed subandine rain forest.

Notes: *Cora caliginosa* is similar a few other, terrestrial, medium-sized, dark olive-grey to olive-brown species, such as *C. casasolana* from Mexico (see below) and *C. pichinchensis* from Ecuador (see below). All three fall in the same subclade of *Cora* but are not closely related. *Cora casasolana* differs by the more greenish tinge, being a (sub-)alpine species, whereas *C. pichinchensis* has a brownish tinge and is a paramo species. The soon confluent hymenophore of *C. caliginosa* might provide a diagnostic feature, but the hymenophore is so far unknown in similar taxa.

***Cora campestris* Dal Forno, Eliasaro & Spielmann spec. nov.**

Index Fungorum: 552391; **Faces Of Fungi:** 02546; Fig. 4K

Etymology: The epithet is a reference to the ecology of this species, found in campos de altitude (high altitude fields) in southeastern Brazil.

Holotype: Eliasaro 2482a (UPCB).

ITS barcoding sequence: KJ780578 (holotype).

Diagnosis: A medium-sized, saxicolous *Cora* with olive-grey lobes with undulate surface.

Thallus growing over bryophytes on rock, foliose, up to 8 cm across, composed of 3–5 semicircular, adjacent to subimbricate lobes; individual lobes 1–2.5 cm wide and 2–4 cm long, sparsely branched and with short, radial branching sutures, surface dark olive-grey when hydrated, with slight concentric colour zonation, with distinct, involute, light grey margins, becoming grey with yellowish tips in the herbarium. Upper surface even to very shallowly concentrically undulate when fresh, undulate when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), light grey when fresh and in the herbarium. Thallus in

section 275–350 μm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 15–30 μm thick layer of densely packed, periclinal, 2–3 μm thick hyphae supported by a 25–75 μm high ‘medullary’ layer of spaced groups of more densely packed, anticlinal, 3–5 μm thick hyphae; photobiont layer 180–205 μm thick, orange-brown above, aeruginous-green below; medulla 35–95 μm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as dense, reticulate, resupinate patches, individual patches rounded to elongate, up to 2 mm long and up to 15 mm broad, with orange-brown, smooth to felty surface and involute margins; hymenophore in section 90–130 μm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 19–25 $\times$ 4–6 μm ; basidia 20–30 $\times$ 4–6 μm , 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: BRAZIL. Paraná: Guaratuba, Morro dos Perdidos; 25°53'S, 48°57'W, 1200 m; 31 August 2002, Eliasaro 2482a (UPCB **holotype**; GMUF **isotype**). Espírito Santo: Ibitirama, Parque Nacional do Caparaó, Pico da Bandeira; 20°26'S, 41°48'W, 2890 m; 8 February 2012, Spielmann et al. 10036 (CGMS-35037, GMUF **paratypes**).

Distribution and ecology: Growing on exposed rock outcrops, generally amongst bryophytes, in the campos rupestres ecoregion, specifically in the campos de altitude or high altitude fields, in southeast Brazil. This ecoregion is found dispersed over a broad area in the southern Atlantic forest and is dominated by low vegetation, mostly of herbaceous and few shrubby plants.

Notes: *Cora campestris* is a medium-sized, grey-brown, saxicolous species, which does not closely resemble any other rock-dwelling species in the genus; it is also characterized by the short, radial branching sutures and the differential colour between the upper and the lower photobiont layer. Among other saxicolous species, it is similar to *C. leslactuca* in size, but the latter is distinguished by the erect, ear-shaped lobes, among other characters. *Cora fuscodavidiana*, another saxicolous taxon, is differentiated by the smaller size and the presence of soredia.

***Cora canari* Nugra, Dal Forno & Lücking spec. nov.**

Index Fungorum: 552392; **Faces Of Fungi:** 02547; Fig. 4K

Etymology: This *Cora* is dedicated to one of the original indigenous people of pre-Incan Ecuador, the Cañari, inhabiting what are now the provinces of Cañar and Azuay (Cordero-Palacios 1981). From the latter province, David Hawksworth described the lichenicolous fungus *Roselliella peltigericola* (Hawksworth and Miadlikowska 1997).

Holotype: Nugra 867 (HA).

ITS barcoding sequence: KJ780394 (holotype).

Diagnosis: A small to mid-sized, epiphytic *Cora* with undulate, aeruginous-green to emerald-green lobes.

Thallus epiphytic on branches of trees, foliose, up to 5 cm across, composed of 3–5 semicircular, adjacent to dispersed lobes; individual lobes 1–2 cm wide and 0.7–1.5 cm long, unbranched to sparsely branched, without radial branching sutures, surface aeruginous-green to emerald-green when fresh, without concentric colour zonation, with thin, involute, grey margins, becoming green-grey in the herbarium. Upper surface undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white–grey when fresh, becoming grey in the herbarium. Thallus in section 200–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged, 4–6 µm thick hyphae supported by a 30–70 µm high ‘medullary’ layer of spaced groups of irregularly arranged, 4–6 µm thick hyphae; photobiont layer 40–70 µm thick, aeruginous; medulla 40–70 µm thick, hydrophobic; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: ECUADOR. Morona Santiago: Mendez, Sopladora Hydroelectric Project; 02°36'S, 78°26' W, 1581 m; 4 February 2010, Nugra 867 (HA **holotype**; B **isotype**).

Distribution and ecology: Only known from the type locality in the lower montane rain forest zone, growing epiphytically on tree trunks and branches between bryophytes and other lichens, including *Coccocarpia* spp.

Notes: *Cora canari* resembles the terrestrial species *C. hafecesweorthensis* and *C. imi* in colour and surface morphology, but grows epiphytically and is much smaller in size. Without molecular data, one would probably assume that *C. canari* is a young, epiphytic form of one of the latter two species; however, phylogenetically, *C. canari* is not closely related to these two taxa and instead positioned in a diverse clade including *C. setosa* L. Vargas, Moncada & Lücking and *C. undulata* L. Vargas, Moncada & Lücking from Colombia (Vargas et al. 2014), as well as two endemic species from Galapagos, including *C. santacruzensis* described below (Fig. 2; Online Supplement D).

***Cora caraana* Lücking, Martins & Lucheta spec. nov.**

Index Fungorum: 552393; **Faces Of Fungi:** 02548; Fig. 4M–O

Etymology: The epithet refers to the type locality in the municipality of Caraá in Rio Grande do Sul state, Brazil.

Holotype: Lücking 37616 (HAS).

ITS barcoding sequence: KX772512 (holotype).

Diagnosis: A small to mid-sized, epiphytic rain forest *Cora* with aeruginous green lobes with even surface when

fresh and rather large, more or less concentrically arranged hymenophore patches.

Thallus epiphytic on tree branches, between and partly overgrown by bryophytes (hepatics), foliose, up to 7 cm across, composed of 5–10 semicircular, adjacent to distant lobes; individual lobes 0.5–1.5 cm wide and 0.5–1 cm long, moderately branched, with short, indistinct, radial branching sutures, surface aeruginous green when fresh, without concentric colour zonation, with thin, involute, light grey margins, becoming grey in the herbarium. Upper surface more or less even when fresh, rugose when dry, glabrous; involute margins glabrous or becoming pilose along the sutures; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), green-grey when fresh, becoming bluish grey in the herbarium. Thallus in section 150–200 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex formed by a 10–20 µm thick layer of densely packed, neatly periclinal, 4–5 µm thick hyphae supported by a 40–50 µm high ‘medullary’ layer of spaced groups of anticlinal, 4–5 µm thick hyphae; photobiont layer 50–100 µm thick, deep aeruginous; medulla 30–50 µm thick, hydrophobic; clamp connections absent but lowermost medullary layer with small, papilliform to coralloid hyphae 2–3 µm thick. Hymenophore corticioid-cyphelloid, developed as rounded to elongate, somewhat prominent to sessile, concave patches forming diffusely concentric lines, patches 1–2 mm long and 1–5 mm broad, with cream-coloured, smooth surface and rough, involute margins; hymenophore in section 40–70 µm thick, supported by a thickened medullary layer, strongly hydrophobic; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 5–6 µm; basidia (few observed) 20–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: BRAZIL. Rio Grande do Sul: Caraá, Caraá Environmental Protection Area; 29°42'S, 50°17'W, 410 m; 21 September 2014, Lücking 37616 (HAS **holotype**; B **isotype**); *ibid.*, Spielmann 11216 (CGMS, GMUF **paratypes**).

Distribution and ecology: Known only from the type locality in Rio Grande do Sul state in southern Brazil, representing the southernmost extension of the tropical montane Atlantic rain forest, growing epiphytically on tree branches in shady conditions.

Notes: *Cora caraana* is an epiphytic montane rain forest species, similar in morphology to several other, medium-sized epiphytic species found in montane rain forest, but characterized particularly by the comparatively large, minutely cyphelloid hymenophore patches. Most similar is *C. boleslia* from Bolivia (see above), which has a less distinct bluish tinge and in which the hymenophore is unknown. Both species are not closely related: *C. boleslia*

is related to *C. aspera*, whereas *C. caraana* falls in a clade with *C. verjonensis* from Colombia and *C. viliewoa* from Costa Rica (see below), among other species (Fig. 2; Online Supplement D). The latter two are also similar to *C. caraana*, but differ in the hymenophore, being distinctly corticioid in *C. viliewoa* and adnate-confluent in *C. verjonensis*. Other similar species are *C. canari* from Ecuador (see above), which differs by its strongly undulate lobes, and *C. smaragdina* from Costa Rica (see below), with scattered surface hairs.

***Cora casasolana* Moncada, R.-E. Pérez & Lücking spec. nov.**

Index Fungorum: 552394; *Faces Of Fungi*: 02549; Fig. 5A

Etymology: Named after Dr. José Arturo Casasola Gonzáles, entomologist from Universidad de la Sierra Juárez in Oaxaca, Mexico, who participated in the field trip and assisted with logistics, sharing his profound knowledge about the ecology of the visited sites.

Holotype: Moncada & Pérez 10257 (EB-BUAP).

ITS barcoding sequence: KX772540 (holotype).

Diagnosis: A medium-sized, terrestrial *Cora* with sparsely branched, dark olive-green to olive-grey, even to shallowly undulate lobes when fresh.

Thallus terrestrial, foliose, up to 10 cm across, composed of 3–7 semicircular, adjacent to subimbricate lobes; individual lobes 1–3 cm wide and 1–2 cm long, ascending, sparsely to moderately branched, without distinct, radial branching sutures, surface dark olive-green to olive-grey when fresh, without concentric colour zonation, with thin, involute, light yellowish grey margins, becoming white-grey in the herbarium. Upper surface even to very shallowly undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light grey in the herbarium. Thallus in section 200–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae supported by a 50–70 µm high ‘medullary’ layer of spaced groups of more densely packed, more or less anticlinal, 4–6 µm thick hyphae; photobiont layer 100–150 µm thick, orange above, aeruginous-green below; medulla 30–60 µm thick; clamp connections absent but, lowermost medullary layer with numerous short, partly branched to coralloid, papilliform hyphae 3–4 µm thick. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: MEXICO. Oaxaca: Santiago Comaltepec, Cerro Pelón; 17°35'N, 96°30'W, 2990 m; 17 May 2015, Moncada & Pérez 10257 (EB-BUAP **holotype**; **B isotype**).

Distribution and ecology: Mixed tropical-temperate cloud forest and alpine, shrubby grassland in southern Mexico, thus far only known from the type locality in Oaxaca, growing terrestrial between plants.

Notes: *Cora casasolana* is similar to a few other terrestrial species with dark olive lobes when fresh. Among these, *C. caliginosa* from Peru (see above) differs in the more greyish lobes when fresh, with scattered trichomes, and the lack of papillae on the underside, whereas *C. pichinchensis* from Ecuador (see below) has more brownish lobes when fresh, with more distinct margins. The only epiphytic, medium-sized species with olive lobes when fresh, *C. hawksworthiana* (see below), produces soredia along the margins and on the surface.

***Cora caucensis* Moncada, M. Gut. & Lücking spec. nov.**

Index Fungorum: 552395; *Faces Of Fungi*: 02550; Fig. 5B

Etymology: Named after the province of the type locality in Colombia.

Holotype: Moncada 7144 (UDBC).

ITS barcoding sequence: KX772716 (holotype).

Diagnosis: A mid-sized, terrestrial species with light grey-green thallus when fresh, differing from *Cora palustris* in the even lobe surface and shortly pilose margins.

Thallus subterrestrial over bryophytes, grasses or dead organic matter, foliose, up to 5 cm across, composed of 3–5 semicircular, adjacent lobes; individual lobes 1–3 cm wide and 2–2 cm long, sparsely branched, without radial branching sutures, surface rather light grey-green when fresh, with slight concentric colour zonation, with thin, involute, light grey margins, becoming grey in the herbarium but producing a weak reddish pigment when rewetting. Upper surface even when fresh red, shallowly undulate when dry, glabrous; involute margins thinly and shortly pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white-grey when fresh, becoming yellowish grey in the herbarium. Thallus in section 270–350 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–40 µm thick layer of densely packed, perpendicular, 4–6 µm thick hyphae supported by a 50–70 µm high ‘medullary’ layer of spaced groups of anticlinal arranged, 4–6 µm thick hyphae; photobiont layer 80–120 µm thick, dark aeruginous; medulla 80–120 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as completely adnate, irregular, large and ragged, resupinate patches, irregularly to concentrically arranged, patches 5–10 mm diam. long and up to 3 cm broad, with cream-coloured, smooth surface and indistinct margins; hymenophore in section 90–100 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 25–35 × 4–6 µm; basidia



◀ **Fig. 5** **A** *Cora casasolana* (isotype, rewetted). **B** *C. caucensis* (holotype). **C** *C. celestino* (holotype). **D, E** *C. comaltepeca* (isotype, in **D** rewetted, in **E** underside with hymenophore). **F, G** *C. corani* (isotype, in **F** rewetted, in **G** underside with hymenophore). **H** *C. corelleslia* (isotype, rewetted, with inlet showing lower medullary papillae). **I, J** *C. crispellesia* (**I**, holotype; **J**, isotype, underside with hymenophore). **K** *C. cuzcoensis* (isotype). **L** *C. dalehana* (holotype). **M** *C. davibogotana* (holotype). **N, O** *C. davicrinita* (**N** Moncada & Lücking 7776, with inlet showing section through thallus; **O** isotype). Scale = 10 mm, in **H** (inlet) = 10 µm, in **N** (inlet) = 100 µm

25–35 × 4–5 µm, 4-sterigmate; basidiospores not observed. Chemistry: Producing a reddish pigment upon rewetting.

Material examined: COLOMBIA. Cauca: Inza, paramo of Guanacas, Las Delicias; 02°23'N, 76°14'W, 3327 m; 13 October 2013, Moncada 7144 (UDBC **holotype**; **B isotype**).

Distribution and ecology: Known only from the type locality in paramo vegetation in southern Colombia, growing on the ground between bryophytes and grasses.

Notes: This is a rather non-descript species without any special characters. It is distinguished from other terrestrial species chiefly by the light grey-green colour and even lobe surface, in combination with a shortly pilose lobe margin. The most similar taxon is *Cora palustris* from Costa Rica (see below), which agrees in ecology, size and colour, but has an undulate lobe surface with glabrous margins. Other terrestrial species of this size have darker olive-grey to olive-brown or bright aeruginous green thalli when fresh and may differ in anatomical features such cortex structure and medullary papillae.

Cora celestino Moncada, Cabrera-Amaya & Lücking **spec. nov.**

Index Fungorum: 552396; **Faces Of Fungi:** 02551; **Fig. 5C**

Etymology: This new species is dedicated to José Celestino Mutis (1732–1808), a Spanish botanist who made important contributions to Colombian botany, leading the Royal Botanical Expedition to Colombia from 1783 to 1808, which explored a huge area along the Río Magdalena into the interior of Colombia.

Holotype: Lücking & Moncada 39438 (JBB).

ITS barcoding sequence: KX772596 (holotype), KX772595 (paratype).

Diagnosis: A mid-sized, terrestrial species with olive colour and strongly and narrowly undulate lobe surface, featuring a collapsed-compacted cortex.

Thallus terrestrial over mosses, foliose, up to 5 cm across, composed of 10–20 semicircular, adjacent to subimbricate, ascending lobes; individual lobes 1–2 cm wide and 1–2 cm long, sparsely to moderately branched, without radial branching sutures, surface olive-grey to olive-brown when fresh, without concentric colour

zonation, with thick, involute, whitish margins, becoming dark grey in the herbarium. Upper surface distinctly and narrowly undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white-grey when fresh, becoming grey in the herbarium. Thallus in section 200–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex collapsed-compacted, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged to perpendicular, 4–6 µm thick hyphae; photobiont layer 80–100 µm thick, orange-brown (upper portion) to aeruginous (lower portion); medulla 80–100 µm thick, hydrophobic; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Distrito Capital: Bogotá, paramo of Sumapaz; 04°17'N, 74°13'W, 3700 m; 13 August 2015, Lücking & Moncada 39438 (with Cabrera-Amaya et al.) (JBB **holotype**; **B isotype**). Caldas: Nevado del Ruiz; 04°59'N, 75°20'W, 3750 m; 2 August 2015, Lücking & Moncada 39376 (**B**, JBB **paratypes**).

Distribution and ecology: Growing on the ground between bryophytes in the paramo regions of the central Colombian Andes.

Notes: This is one of about a dozen species with terrestrial growth habit and mid-sized thalli, sharing with several other taxa the olive-grey to olive-brown colour, but differing in the strongly and narrowly, concentrically undulate lobe surface. *Cora caliginosa* from Peru (see above), *C. pichinchensis* from Ecuador, and *C. terrestris* from Costa Rica (see below) have shallowly undulate lobes and in part darker thalli when fresh, and while *C. caliginosa* and *C. terrestris* have a viaduct-shaped cortex, *C. pichinchensis* differs in its plectenchymatous cortex. *Cora ciferrii* and *C. paraciferrii* (see below) are also similar to the new species in substrate ecology, colour, and the undulate lobe surface, but produce large thalli and lobes. Notably, none of these taxa is related to *C. celestino*, which is found at the base of one of the two large *Cora* clades, while all similar species are found in the other clade (Fig. 2; Online Supplement D).

Cora comaltepeca Moncada, R.-E. Pérez & Herrera-Camp. **spec. nov.**

Index Fungorum: 552397; **Faces Of Fungi:** 02552; **Fig. 5D, E**

Etymology: The epithet refers to the type locality.

Holotype: Moncada & Pérez 10233 (UDBC).

ITS barcoding sequence: KX772556 (holotype).

Diagnosis: A small, epiphytic *Cora* with olive-green lobes when fresh, with sparse, marginal to submarginal soredia.

Thallus epiphytic on branches, foliose, up to 5 cm across, composed of 5–10 semicircular, subimbricate lobes; individual lobes 0.5–1 cm wide and 0.5–1 cm long, ascending to erect, sparsely to moderately branched, without distinct, radial branching sutures, surface olive-green when fresh, without concentric colour zonation, with distinct, involute, light grey margins, becoming white–grey in the herbarium with dark grey submarginal zone. Upper surface shallowly undulate when fresh, undulate-rugose when dry, glabrous, sometimes with scattered soredia; involute margins glabrous, partly becoming granular-sorediate; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), olive-grey with whitish areas when fresh, becoming grey in the herbarium. Thallus in section 200–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae supported by a 50–70 µm high ‘medullary’ layer of spaced groups of irregularly arranged to anticlinal, 4–6 µm thick hyphae; photobiont layer 50–100 µm thick, aeruginous-green; medulla 50–80 µm thick; clamp connections absent but lower medullary hyphae with papilliform, globose to branched hyphae 2–3 µm thick. Hymenophore corticioid, composed of resupinate, rounded to elongate patches 0.3–0.5 mm long and 0.3–3 mm broad, with cream-coloured to light yellowish, smooth surface and thin, involute, rough margins; hymenophore in section 80–120 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–25 × 4–6 µm; basidia and basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: MEXICO. Oaxaca: Santiago Comaltepec, Cerro Las Antenas; 17°35'N, 96°27'W, 2190 m; 17 May 2015, Moncada & Pérez 10233 (BUAP **holotype**; B **isotype**).

Distribution and ecology: Mixed tropical-temperate cloud forest in southern Mexico, thus far only known from the type locality in Oaxaca, growing epiphytic on tree branches.

Notes: *Cora comaltepeca* is one of several small, epiphytic, marginally sorediate species, including *C. davicrinita* (see above), *C. minutula* (see below), *C. rothesiorum* (see below), and *C. subdavicrinita* (see below). Among these, *C. davicrinita* and *C. subdavicrinita* differ in their arachnoid-pilose lobe surface, whereas *C. minutula* has smaller thalli with irregularly shaped lobes with rather thick, thinly pilose margins. *Cora rothesiorum* is most similar to *C. comaltepeca* but its lobes are irregularly crisp and have a bluish tinge when fresh.

Cora corani Lücking, E. Morales & Dal Forno **spec. nov.**

Index Fungorum: 552398; **Faces Of Fungi:** 02553; Fig. 5F, G

Etymology: Named after the type locality, Corani Reservoir in Bolivia, here used as a noun in apposition.

Holotype: Lücking 29356 (HCUCB-451).

ITS barcoding sequence: KJ780369, KJ802418 (holotype; KJ802418 from 454 pyrosequencing).

Diagnosis: A mid-sized to large terrestrial *Cora* with much branched, olive-grey lobes when fresh and resupinate, subreticulate hymenophore.

Thallus terricolous between and over bryophytes, foliose, up to 20 cm across, composed of 5–15 semicircular, adjacent to subimbricate lobes; individual lobes 3–5 cm wide and 3–7 cm long, moderately to frequently branched and with long, radial branching sutures, surface olive-grey to reddish brown when fresh, without distinct concentric colour zonation, with thin, involute, light brown margins, becoming grey with dark grey margins in the herbarium. Upper surface shallowly undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light yellowish grey in the herbarium. Thallus in section 250–350 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex distinctly viaduct-shaped, formed by a 20–30 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae supported by a 50–70 µm high ‘medullary’ layer of spaced groups of irregularly arranged to anticlinal, 4–6 µm thick hyphae; photobiont layer 100–150 µm thick, orange-brown above, olive-green below; medulla 70–100 µm thick, hydrophobic; clamp connections absent, papilliform hyphae absent. Hymenophore developed as rounded to irregular to elongate, resupinate patches forming concentric, partially anastomosing and reticulate lines, patches 0.5–2 mm long and 0.5–5 mm broad, with cream-coloured, smooth surface and smooth to uneven, involute margins; hymenophore in section 80–100 µm thick, supported by a thickened medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: BOLIVIA. Cochabamba: Chapare, Corani Reservoir; 17°16'S, 65°54'W, 3260 m; 7 July 2009, Lücking 29356 (HCUCB-451 **holotype**; F **isotype**).

Distribution and ecology: Only known from the type locality growing terricolous over bryophytes and associated with other lichens, including *Hypotrachyna* species.

Notes: *Cora corani* is similar to some other terrestrial species such as *C. ciferrii* (Lücking et al. 2014b), but differs in the more flattened, more frequently branched lobes with shallow undulation. It is a rather non-descript species, its phylogenetic distinctiveness being supported principally by geography. Its closest described relative is *C. setosa*

from Colombia (Vargas et al. 2014), whereas *C. ciferri* is only distantly related (Lücking et al. 2014b). The species was included in broad concept of *C. aspera* Wilk, Lücking & E. Morales (Lücking et al. 2013a), but forms a separate clade, also differing in its substrate ecology (Lücking et al. 2014b).

***Cora corelleslia* Moncada, A. Suárez-Corredor & Lücking spec. nov.**

Index Fungorum: 552399; *Faces Of Fungi*: 02554; Fig. 5H

Etymology: This species superficially resembles a species of *Corella*, so we combined this genus name with David's second name, Leslie, to form the epithet.

Holotype: Moncada & Suárez 5404 (UDBC).

ITS barcoding sequence: KJ780498 (holotype).

Diagnosis: A small *Cora* resembling the genus *Corella* in size and colour, with compacted cortex.

Thallus over bryophytes (*Frullania* etc.) overgrowing the bark of shrubs or near the ground, foliose, up to 5 cm across, composed of 3–8 semicircular to irregular, adjacent lobes; individual lobes 0.8–1.5 cm wide and 0.5–1 cm long, sparsely branched and without radial branching sutures, surface dark green when fresh, without concentric colour zonation, with thin, involute, whitish margins, becoming bluish grey in the herbarium. Upper surface undulate when fresh, smooth to rugose when dry, glabrous; involute margins glabrous to thinly pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white to greyish white when fresh, becoming yellowish white in the herbarium. Thallus in section 200–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex compacted, formed by a 10–20 µm thick layer of loosely packed, irregularly arranged, 4–5 µm thick hyphae; photobiont layer 150–200 µm thick, olive-green above, dark aeruginous-green below; medulla 30–50 µm thick, hydrophobic; clamp connections absent but lowermost medullary hyphae with numerous short, globose to cylindrical, mostly unbranched papilliform hyphae 3–4 µm thick. Hymenophore corticioid to cyphelloid, developed marginally as irregular, resupinate patches, patches 0.1–0.3 mm long and 0.3–0.6 mm broad, with yellowish white, smooth to thinly byssoid surface and smooth to felty, involute margins; hymenophore in section 100–120 µm thick; hymenium composed of numerous, palisade-like basidioles; basidioles 20–25 × 2–3 µm; basidia and basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: Villa Pinzón, paramo of Guacheneque; 05°13'N, 73°32'W, 3335 m; 12 May 2012, Moncada & Suárez 5404 (UDBC **holotype**; B **isotype**). Cundinamarca: Guayabetal, Los

Tolimas; 04°17'N 73°48'W, 2778 m; 13 January 2014, Coca et al. 3830 (FAUC **paratype**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes (thus far only known Cundinamarca in Colombia), growing epiphytically over hepatics (*Frullania* sp. and other taxa) over paramo shrubs.

Notes: *Cora corelleslia* is a rather small but morphologically unique species. When fresh, the dark green thallus is reminiscent of a large *Lichenomphalia hudsoniana* (H.S. Jenn.) Redhead et al. or *Marchandiophalina foliacea* (P. M. Jørg.) Diederich, Manfr. Binder & Lawrey (Redhead et al. 2002; Diederich and Lawrey 2007), whereas dried material recalls the related genus *Corella* (Dal Forno et al. 2013; Lücking et al. 2013a). The unique colour is due to a very thin and loose upper cortex which lacks a 'medullary' supporting layer; hence the colour of the photobiont dominates the colour of the lichen. The new species is related to *C. hirsuta* (Moncada & Lücking) Moncada & Lücking and *C. minor* (Lücking, E. Navarro & Sipman) Lücking (Fig. 2; Online Supplement D), which are both morphologically quite different, with whitish lobes and producing either a densely setose surface or brownish, partly sorediate margins (Lücking et al. 2013a).

***Cora crispoleslia* Moncada, J. Molina & Lücking spec. nov.**

Index Fungorum: 552400; *Faces Of Fungi*: 02555; Fig. 5I, J

Etymology: The epithet is a combination of the Latin word *crispulus*, meaning curly, with reference to the crisp lobe margins, and David's second name, Leslie.

Holotype: Lücking & Moncada 34057 (ANDES).

ITS barcoding sequences: KJ780443 (holotype).

Diagnosis: A rather small, epiphytic *Cora* with mottled olive-brown and light grey thallus when fresh and very irregular, crisp, sorediate margins, combined with a completely adnate, emarginate, spot-like hymenophore.

Thallus epiphytic on shrubs, foliose, up to 5 cm across, composed of 5–10 semicircular, subimbricate lobes; individual lobes 0.7–1.5 cm wide and 0.5–1 cm long, sparsely branched, without radial branching sutures, surface mottled olive-brown and light grey when fresh, with the grey spots irregularly to subconcentrically arranged, with distinct, involute, irregularly bent or undulate, crisp, brownish margins, becoming white–grey with olive-green to dark grey margins in the herbarium. Upper surface even when fresh, rugose when dry, glabrous; involute margins granulose to sorediate; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming grey in the herbarium. Thallus in section 270–350 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex very distinctly viaduct-shaped, formed by a 20–30 µm thick layer of densely packed,

periclinal, 4–6 µm thick hyphae supported by a 70–100 µm high ‘medullary’ layer of spaced groups of anticlinal, 4–6 µm thick hyphae; photobiont layer 80–150 µm thick, orange-brown above, olive-green below; medulla 30–50 µm thick, hydrophobic; clamp connections absent, papilliform hyphae absent. Hymenophore corticioid, developed as rounded to irregular, completely adnate and emarginate patches soon becoming confluent and covering large areas of the lower surface, patches at first 0.3–0.5 mm long and 0.3–1 mm broad, when confluent up to 10 mm diam., with white, smooth surface; hymenophore in section 90–120 µm thick, supported by a thickened medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: La Calera, paramo of Chingaza; 04°44'N, 73°52'W, 3600 m; 7 November 2011, Lücking & Moncada 34057 (ANDES **holotype**; B, F **isotypes**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes (Colombia, Ecuador), growing epiphytically on paramo shrubs in shaded to semi-exposed microsites.

Notes: *Cora crispuleslia* is another small, epiphytic, marginally soreidate *Cora*. While similar in general habit to *Cora davicrinia* (see below), *C. minor*, and *C. rothesiorum* (see below), it phylogenetically belongs to another subclade of *Cora*, being related to the morphologically quite different *C. dalehana* and *C. davibogotana* (see below; Lücking et al. 2014b). *Cora rothesiorum* is most similar to *C. crispuleslia* in general habit and ecology, but has a uniformly aeruginous-green thallus.

***Cora cuzcoensis* Holgado, Rivas Plata & Perlmutter spec. nov.**

Index Fungorum: 552401; **Faces Of Fungi:** 02556; Fig. 5K

Etymology: Referring to the type locality in the department of Cuzco.

Holotype: Farfan et al. s.n. (CUZ).

ITS barcoding sequence: KJ780364, KJ802411 (holotype; KJ802411 from 454 pyrosequencing).

Diagnosis: A mid-sized to large, terrestrial *Cora* with (dark) olive-green, concentrically undulate lobes.

Thallus terrestrial over bryophytes, foliose, up to 15 cm across, composed of 5–10 semicircular, adjacent to subimbricate lobes; individual lobes 3–5 cm wide and 2–4 cm long, sparsely to moderately branched and with short, radial branching sutures that become free, surface dark olive-green when fresh, without concentric colour zonation, with thin, involute, olive-grey margins, becoming white-grey in the

herbarium. Upper surface concentrically undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous or with distinct hairs along the free sutures; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), olive-grey to white-grey when fresh, becoming yellowish grey in the herbarium. Thallus in section 270–350 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–30 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae supported by a 50–70 µm high ‘medullary’ layer of spaced groups of more or less densely packed, anticlinal, 4–6 µm thick hyphae; photobiont layer 100–150 µm thick, olive-green above, aeruginous-green below; medulla 70–100 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as irregular to elongate-linear, resupinate patches forming concentric lines and sometimes anastomosing, patches 0.5–2 mm long and 1–10 mm broad, with yellowish to pale orange, smooth surface and indistinct margins; hymenophore in section 100–150 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 30–50 × 4–6 µm, often branched; basidia 25–35 × 5–7 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: PERU. Cuzco: Piscacucho; 13°10'S, 72°21'W, 3500 m; 4 August 2009, Farfan et al. s.n. (CUZ **holotype**; B **isotype**).

Distribution and ecology: Only known from the type locality near Machu Picchu, growing on the ground in the surroundings of a highly disturbed subandine rain forest.

Notes: *Cora cuzcoensis* differs from other medium-sized, terrestrial species in the rather dark, olive-green lobes. Most similar is *C. caliginosa* from the same locality (see above), which differs in the dark olive-grey lobes without greenish tinge and the thicker thallus. Both species are not closely related (Fig. 2; Online Supplement D), emphasizing the importance of molecular data to even separate superficially similar species co-occurring at the same locality, a nice example of pseudocryptic taxa.

***Cora dalehana* Moncada, Madriñán & Lücking spec. nov.**

Index Fungorum: 552402; **Faces Of Fungi:** 02557; Fig. 5L

Etymology: The epithet is a syllable acronym of David's full name.

Holotype: Lücking & Moncada 34012 (ANDES).

ITS barcoding sequence: KJ780434 (holotype).

Diagnosis: A very large, terrestrial *Cora* with light olive-brown, concentrically undulate lobes and a hymenophore consisting of small, irregular to linear patches forming concentric lines.

Thallus terrestrial between bryophytes and other plants, foliose, up to 30 cm across, composed of 10–25 semicircular,

adjacent to subimbricate lobes; individual lobes 5–10 cm wide and 3–7 cm long, moderately to frequently branched and with short, radial branching sutures, surface light olive-brown to brown-grey when fresh, without or with slight concentric colour zonation, with thin, involute, cream-coloured margins, becoming grey in the herbarium. Upper surface shallowly undulate and partly shallowly pitted when fresh, undulate-rugose and partly pitted when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), cream-white when fresh, becoming light yellowish grey in the herbarium. Thallus in section 450–550 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–50 µm thick layer of densely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae supported by a 70–100 µm high ‘medullary’ layer of spaced groups of irregularly arranged, 4–6 µm thick hyphae; photobiont layer 150–200 µm thick, olive-green above, aeruginous-green below; medulla 70–150 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as irregular to elongate, resupinate patches forming concentric lines, patches 0.5–1.5 mm long and 1–5 mm broad, with pale orange, smooth surface and rough, involute margins; hymenophore in section 80–100 µm thick, supported by a massive medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: La Calera, paramo of Chingaza; 04°44'N, 73°52'W, 3600 m; 7 November 2011, Lücking & Moncada 34012 (ANDES **holotype**; B, F **isotypes**).

Distribution and ecology: Known from a single collection in the wet paramos of the northern Andes close to Bogotá in Colombia, growing terrestrial between bryophytes (including *Frullania* sp.) and a variety of vascular plants.

Notes: This rather large, terrestrial *Cora* is very similar to *C. ciferrii* (Lücking et al. 2014c), but not related to that species (Lücking et al. 2014b). In *C. ciferrii*, the surface undulation is more pronounced and the hymenophore forms larger, more irregular patches that often become confluent.

***Cora davibogotana* Lücking, Moncada & Coca spec. nov.**

Index Fungorum: 552403; **Faces Of Fungi:** 02558; **Fig. 5M**

Etymology: The epithet is a combination of David's first name and the type locality in the city of Bogotá.

Holotype: Lücking & Moncada 35281 (UDBC).

ITS barcoding sequences: KJ780504 (holotype), KJ780505 (paratype).

Diagnosis: A comparatively large, saxicolous or terrestrial *Cora* with concentrically undulate, dark olive-green to grey-green lobes with a paler grey-green marginal zone.

Thallus saxicolous or terrestrial, foliose, up to 12 cm across, composed of 10–20 semicircular, adjacent to subimbricate lobes; individual lobes 3–5 cm wide and 3–5 cm long, moderately to frequently branched and with short, radial branching sutures, surface dark olive-green to grey-green with paler grey-green marginal zone when fresh, with thin, involute, light greenish grey margins, becoming light grey in the herbarium. Upper surface shallowly undulate and partly pitted when fresh, undulate when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white–grey when fresh, becoming yellowish grey in the herbarium. Thallus in section 200–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped formed by a 30–50 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae supported by a 30–50 µm high ‘medullary’ layer of spaced groups of more densely packed, anticlinal, 4–6 µm thick hyphae; photobiont layer 80–100 µm thick, orange-brown (upper portion) to aeruginous-green (lower portion); medulla 60–100 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as elongate to linear, resupinate patches forming concentric, partially reticulate lines, patches 1–3 mm long and 3–10 mm broad, with pale yellowish, smooth surface and felty, involute margins; hymenophore in section 80–100 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–35 × 4–5 µm; basidia 20–30 × 4–5 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Distrito Capital: Bogotá, El Delirio Reserve; 15°13'N, 90°13'W, 1800 m; 26 August 2012, Lücking & Moncada 35281 (UDBC **holotype**; B, F **isotypes**), 35278 (B, F, UDBC **paratypes**). Cundinamarca: Guayabetal, Los Quicuyales; 04°16'N 73°48'W, 2177 m; 12 January 2014, Coca et al. 3789 (FAUC **paratype**).

Distribution and ecology: Wet subandine cloud forest, only known near Bogotá in Colombia, growing saxicolous or terrestrial in the shady understory.

Notes: *Cora davibogotana* is similar and closely related to *C. dalehana* (see above). Both species differ in habitat (subandine forest versus paramo), substrate ecology (saxicolous versus terricolous) and colour (predominantly greenish with paler marginal zone versus predominantly brownish). This underlines the importance of subtle ecological and morphological differences for species delimitation, which can only be assessed in the field and are entirely lost in herbarium specimens.

***Cora davicrinita* Moncada, Madriñán & Lücking spec. nov.**

Index Fungorum: 552404; *Faces Of Fungi*: 02559; Fig. 5N, O

Etymology: The epithet is a combination of the first name David and the Latin word for fluffy (*crinitus*), a reference to the fluffy, arachnoid-tomentose lobe surface.

Holotype: Lücking & Moncada 34052 (ANDES).

ITS barcoding sequences: KJ780440 (holotype), KX772733, KJ780416, KJ780442, KJ780474, KJ780481, KJ780555 (paratypes).

Diagnosis: A small, epiphytic *Cora* with light olive-green, thinly arachnoid-tomentose surface becoming somewhat fluffy and white when dry, and olive-green to olive-brown, sorediate margins.

Thallus epiphytic on small twigs of shrubs, sometimes between bryophytes or other lichens, macrosquamulose, up to 2 cm across, composed of 5–10 semicircular, adjacent to dispersed lobes; individual lobes 0.3–1 cm wide and 0.2–0.6 cm long, unbranched to sparsely branched and without radial branching sutures, surface light olive-green mottled with white when fresh, without concentric colour zonation, with thick, involute, olive-green to olive-brown margins, becoming white–grey in the herbarium. Upper surface even when fresh, even to rugose when dry, thinly arachnoid-tomentose in concentric bands or in patches; involute margins becoming granulose-sorediate and irregular to crisp in outline; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white–grey when fresh, becoming bluish grey in the herbarium, with scattered tufts of projecting, whitish hairs. Thallus in section 300–400 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–30 µm thick layer of loosely packed, periclinal, 4–6 µm thick hyphae supported by a 50–70 µm high ‘medullary’ layer of spaced groups of anticlinal, 4–6 µm thick hyphae, upper layer in part with emerging trichomes 50–100 µm long and 10–20 µm thick at the base; photobiont layer 70–120 µm thick, olive-green above, aeruginous-green below; medulla indistinct, 20–50 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: La Calera, paramo of Chingaza; 04°44'N, 73°52'W, 3600 m; 7 November 2011, Lücking & Moncada 34052 (ANDES **holotype**; B, F **isotypes**), 34054 (B, UDBC **paratypes**). Cauca: Inza, paramo of Guanacas, Las Delicias; 02°23'N, 76°14'W, 3327 m; 13 October 2013, Moncada 7219 (B, UDBC **paratypes**). Cundinamarca: Guasca, paramo of Guasca; 04°51'N, 73°49'W, 3220 m; 18 August 2011, Lücking & Moncada 33306, 33316 (B, UDBC **paratypes**).

Fig. 6 A–D *Cora davidia* (A Moncada & Lücking 7779, with inlet showing section through thallus; B–D, holotype, in D underside with hymenophore). E, F *C. dewisanti* (E holotype; F Moncada & Lücking 7436). G, H *C. dulcis* (isotype, in G rewetted, in H underside with hymenophore). I, J *C. elephas* (I Lücking & Moncada 32723; J Lücking & Moncada 34114). K *C. fuscodavidiana* (holotype). L, M *C. garagoa* (isotype, in L rewetted, in M underside with hymenophore). N, O *C. gigantea* (holotype, in O underside with hymenophore). Scale = 10 mm, in A (inlet) = 100 µm

Distrito Capital: Bogotá, paramo of Sumapaz; 04°17'N, 74°13'W, 3700 m; 15 August 2010, Lücking & Moncada 32714 (B, UDBC **paratypes**). Nariño: Puerres, paramo of Cerro Negro; 00°52'N, 77°27'W, 3350 m; 26 October 2013, Moncada & Lücking 7773 (UDBC **paratype**), 7776 (UDBC **paratype**); *ibid.*; 00°51'N, 77°25'W, 3420 m; 26 October 2013, Moncada & Lücking 7896 (UDBC **paratype**). ECUADOR. Napo: Oyacachi; 00°12'S, 78°08'W, 3668 m; 23 August 2009, Jonitz et al. 383 (B, QCNE).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes (Colombia, Ecuador), growing epiphytically on twigs of paramo shrubs, often between bryophytes and other lichens such as *Hypotrachyna* species.

Notes: *Cora davicrinita* belongs in a complex of species centered around *C. minor*, to which it is closely related (Lücking et al. 2013a, 2014b). Both species have whitish lobes with dark margins when dry, but in *C. davicrinita* the lobe surface is arachnoid, whereas in *C. minor* it is compact and glabrous. Also, the lobe margins in *C. davicrinita* tend to be more greenish. The *C. minor* clade exhibits a notable geographic vicariance, with two species from Costa Rica forming a clade sister to another clade containing five species from the northern South American Andes, including *C. davicrinita* (Lücking et al. 2014b).

***Cora davidia* Moncada, L. Vargas & Lücking spec. nov.**

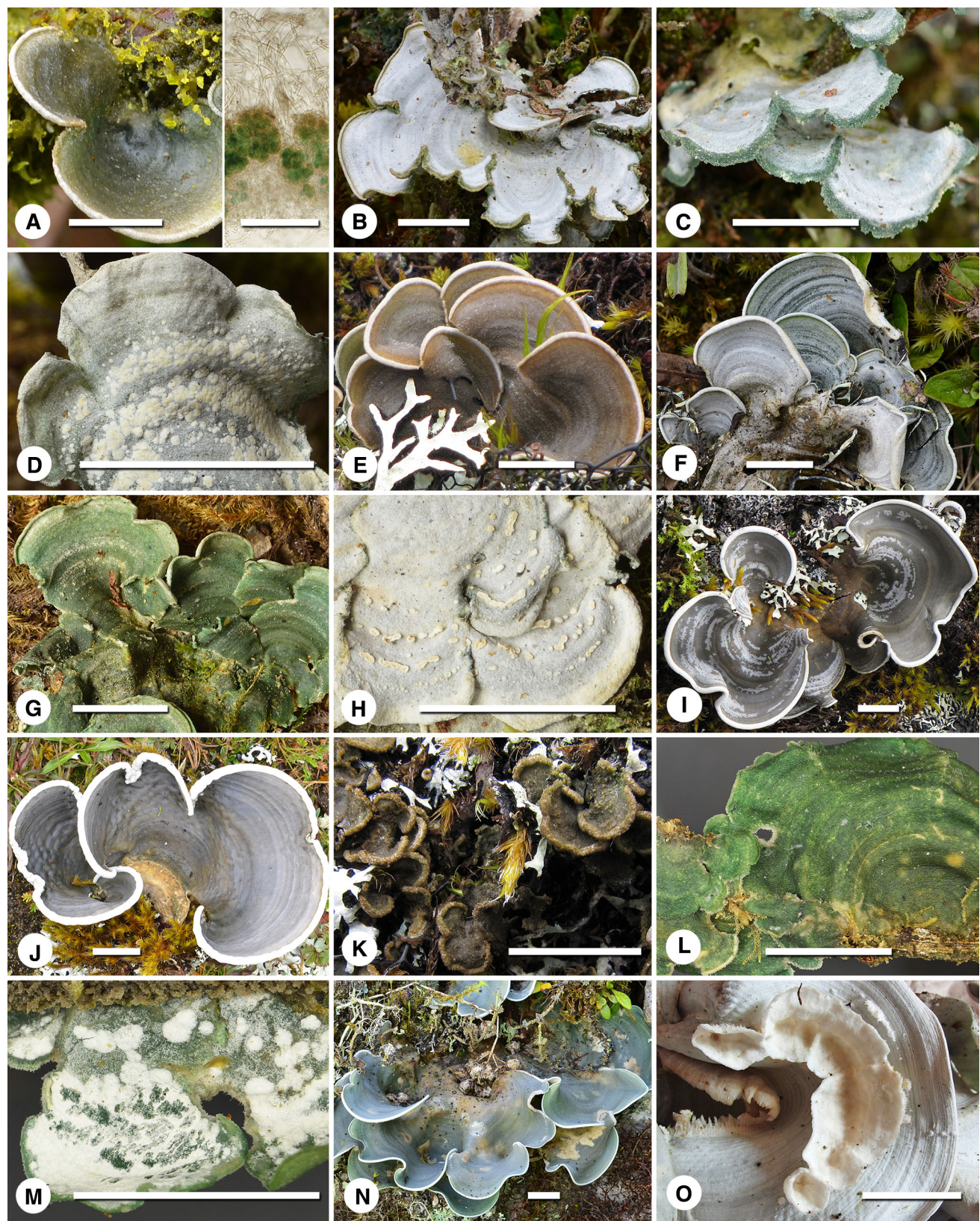
Index Fungorum: 552405; *Faces Of Fungi*: 02560; Fig. 6A–D

Etymology: This species is dedicated to David Hawksworth in recognition of his nomenclatural work on *Dictyonema* s.lat. (Hawksworth 1988; Lücking and Hawksworth 2007), including the well-known name *D. glabratum* (Spreng.) D. Hawksw. used for the only recognized species in what is now known to represent the megadiverse genus *Cora*.

Holotype: Moncada & Lücking 7771 (UDBC).

ITS barcoding sequence: KX772658 (holotype), KX772676, KX772696, KX772741, KX772487, KX772516, KX772536 (paratypes).

Diagnosis: A medium-sized, epiphytic *Cora* with some lobes forming abundant, marginal soredia, with adnate-confluent, emarginate hymenophore.



Thallus epiphytic on branches of shrubs and trees, foliose, up to 7 cm across, composed of 3–7 semicircular, adjacent to subimbricate lobes; individual lobes 1–3 cm wide and 1–3 cm long, moderately to frequently branched, forming various terminal lobules, with short, radial branching sutures, surface olive-green when fresh but soon becoming whitish while still hydrated, with slight concentric colour zonation, with distinct, involute, brownish margins in part producing abundant, olive-green to aeruginous-green soredia, becoming white-grey in the herbarium with the soredia becoming olive. Upper surface even when fresh, rugose when dry, glabrous; involute margins glabrous to granulose, in part of the lobes becoming densely sorediate including along the sutures; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), greenish-grey when fresh, becoming light grey in the herbarium. Thallus in section 200–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 30–50 µm thick layer of loosely packed, more or less periclinal, 4–6 µm thick hyphae supported by a 50–70 µm high ‘medullary’ layer of spaced groups of anticlinal, 4–6 µm thick hyphae; photobiont layer 70–100 µm thick, aeruginous-green; medulla 50–100 µm thick, strongly hydrophobic; clamp connections absent but lowermost medullary hyphae with numerous, globose, papilliform hyphae 3–4 µm thick. Hymenophore corticioid, developed as rounded to irregular, completely adnate and emarginate patches soon becoming confluent and covering large areas of the lower surface, patches at first 0.3–0.5 mm long and 0.3–0.5 mm broad, when confluent forming concentric patches up to 2 × 10 mm diam., with cream-white, smooth surface; hymenophore in section 20–30 µm thick, above a thickened, supporting medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 5–6 µm; basidia (few observed) 25–35 × 5–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Nariño: Puerres, paramo of Cerro Negro; 00°52'N, 77°27'W, 3350 m; 26 October 2013, Moncada & Lücking 7771 (UDBC **holotype**; **B isotype**). Casanare: Chámeza, Finca El Triunfo; 05°12'N, 72°54'W, 1400 m; 24–31 January 2012, Vargas & Herrera 1125 (B, UDBC **paratypes**). Cundinamarca: Choachí, Matarredonda Ecological Park, El Verjón; 04°34' N, 74°00'W, 3220 m; 10 March 2012, Moncada & Lücking 5359 (B, UDBC **paratypes**); *ibid.*, 3350 m; 27 November 2014, Moncada 8807 (B, UDBC **paratypes**). Nariño: Puerres, paramo of Cerro Negro; 00°52'N, 77°27'W, 3350 m; 26 October 2013, Moncada & Lücking 7779, 7781, 7791 (B, UDBC **paratypes**). Putumayo: Santiago, Laguna de la Cocha; 01°08'N 77°05'W, 3165 m; 29 March 2014, Coca & Rodóñez-Casanova (FAUC **paratype**).

ECUADOR. Carchi: Morán; 00°46'N, 78°02'W, 3230 m; 4 December 2013, Jonitz et al. 1227 (B, QCNE **paratypes**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes (Colombia and Ecuador), growing epiphytically on twigs of shrubs and small trees in shaded to semi-exposed conditions.

Notes: *Cora davidia* is one of three medium-sized, epiphytic species producing soredia, the others being *C. crispoleslia* from Colombia (see above) and the widely distributed *C. hawksworthiana* (see below). The latter has a darker olive thallus when wet and the soredia are produced both along the margins and in concentric bands on the surface. *C. crispoleslia* is the sister species of *C. davidia* (Lücking et al. 2014b) and shares the adnate-confluent hymenophore, but has much more irregular, crisp margins. Both *C. davidia* and *C. hawksworthiana* are the largest sorediate, epiphytic species and have the widest distribution ranges in the genus, suggesting that conspicuous epiphytic species with soredia disperse more easily than other species.

Cora dewisanti Moncada, A. Suárez-Corredor & Lücking **spec. nov.**

Index Fungorum: 552406; *Faces Of Fungi*: 02561; Fig. 6E, F

Etymology: The personal name David has been especially popular in Wales, being used in honor of the 6th-century patron Saint David of Wales. The epithet refers to the Welsh version of the name, Dewi Sant.

Holotype: Lücking & Moncada 32700 (UDBC).

ITS barcoding sequences: KJ780405 (holotype), EU825957, KJ780403, KJ780407, KJ780409, KJ780412, KJ780414, KJ780449, KJ780469, KJ780482, KJ780484, KJ780486, KJ780667, KJ780676 (paratypes).

Diagnosis: A mid-sized *Cora* growing terrestrially between bryophytes and other lichens, fresh with olive-green to olive-brown lobes lacking distinct colour zonation except when dry, with mostly glabrous surface except for concentric bands of whitish setae, and with distinct, whitish, glabrous margins.

Thallus terrestrial between bryophytes and other lichens, foliose, up to 10 cm across, composed of 5–10 semicircular, imbricate lobes; individual lobes 1–3 cm wide and 1–3 cm long, moderately to frequently branched and with short, radial branching sutures, surface olive-brown to olive-green when fresh, without concentric colour zonation, with distinct, involute, whitish to greyish margins, becoming grey with yellowish margins in the herbarium, with very distinct concentric colour zonation. Upper surface even to shallowly undulate when fresh, undulate-rugose when dry, mostly glabrous but with concentric bands of white setae; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the

exposed medulla), whitish when fresh, becoming yellowish white in the herbarium. Thallus in section 300–400 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-diffusely shaped, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae supported by a 50–70 µm high ‘medullary’ layer of spaced groups of anticlinal, 4–6 µm thick hyphae, upper layer with emerging setae of agglutinate hyphae, setae 100–200 µm long and 15–20 µm thick at the base; photobiont layer 100–150 µm thick, orange-brown above, olive-green below; medulla 30–70 µm thick, hydrophobic; clamp connections absent, papilliform hyphae absent. Hymenophore corticoid-cyphelloid, developed as rounded to irregularly elongate, resupinate patches, patches 1–5 mm long and 1–10 mm broad, with cream-coloured, smooth surface and felty, involute margins; hymenophore in section 100–120 µm thick, resting on a thick medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–35 × 5–7 µm; basidia 30–40 × 5–7 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Distrito Capital: Bogotá, paramo of Sumapaz; 04°17'N, 74°13'W, 3700 m; August 2010, Lücking & Moncada 32700 (UDBC **holotype**; B, F **isotypes**); *ibid.*, Lücking & Moncada 32703, 32705, 32710, 32712 (B, F, UDBC **paratypes**); *ibid.*, 3730 m; 3 December 2011, Lücking & Moncada 34107 (B, UDBC **paratypes**); *ibid.*; 3 December 2011, Coca 2018b, 2028b (B, F, FAUC **paratypes**). Cauca: Inzá, paramo of Guanacas-Las Delicias; 02°30'N, 76°14'W, 3330 m; 16 October 2013, Moncada 7221 (UDBC **paratype**). Cundinamarca: Guasca, paramo of Guasca; 04°51'N, 73°49'W, 3220 m; 18 August 2011, Lücking & Moncada 33307, 33349, 33384 (B, UDBC **paratypes**). Junín, Peña de Santa Bárbara Natural Reserve; 04°49'N, 73°45'W, 2520 m; 11 November 2012, Moncada et al. 6301 (B, UDBC **paratypes**). Nariño: Pasto, paramo of La Divina Pastora; 01°11'N, 77°11'W, 3210 m; Moncada & Lücking 7436 (UDBC **paratype**). Puerres, paramo of Cerro Negro; 00°52'N, 77°27'W, 3350 m; 26 October 2013, Moncada & Lücking 7894 (UDBC **paratype**). Risaralda: Santuario, Planes de San Rafael, Tatamá Natural National Park; 05°08'N, 76°04'W, 3000 m; 17 January 2011, Coca et al. 1423 (B, F, FAUC **paratypes**). VENEZUELA. Mérida: Sierra Nevada National Park; 08°47'N, 70°49'W, 3630 m; 6 December 2009, Hernández 1782 (VEN **paratype**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes (Venezuela to Ecuador), growing terrestrially between bryophytes and other lichens in semi-exposed microsites.

Notes: This species is related to the *Cora elephas* complex (see below; Lücking et al. 2014a, b, c), *C. elephas*

differing in the larger, sparsely branched lobes with grey colour when fresh, a glabrous upper surface, and very thick, white margins, as well as its predominantly saxicolous growth. The material now recognized as *C. dewisanti* was first included in the newly described *C. arachnoidea* J.E. Hern. & Lücking and used to illustrate that species (Lücking et al. 2013a), but the molecular data subsequently available showed that *C. arachnoidea* s.lat. is a complex of several lineages (Lücking et al. 2014b), with *C. arachnoidea* s.str. being typified by a specimen from Venezuela (Hernández 1780), but also known throughout Colombia and from Ecuador. Thus, both *C. arachnoidea* and *C. dewisanti* have a similar distribution but differ phylogenetically and in morphology and substrate ecology, with *C. arachnoidea* being predominantly epiphytic and having light greenish grey lobes when fresh, with a more distinct tomentum and with numerous marginal branches. The marked colour contrast between fresh and herbarium specimens of *C. dewisanti* is more pronounced than in most other species in the genus.

Cora dulcis Moncada, R.-E. Pérez & Lücking **spec. nov.**

Index Fungorum: 552407; *Faces Of Fungi*: 02562; Fig. 6G, H

Etymology: Named after Dr. Dulce María Figueroa Castro, ecologist from Benemérita Universidad Autónoma de Puebla in Puebla, Mexico, who co-organized the field trip and quickly became interested in lichen ecology; the Latin epithet *dulcis* corresponds to the Spanish adjective dulce, meaning sweet.

Holotype: Moncada & Pérez 10288 (EB-BUAP).

ITS barcoding sequence: KX772551 (holotype).

Diagnosis: A medium-sized, terrestrial *Cora* with aeruginous-green, more or less even lobes when fresh and a hymenophore forming concentric lines.

Thallus terrestrial between and over bryophytes, foliose, up to 5 cm across, composed of 5–10 semicircular, adjacent to subimbricate lobes; individual lobes 1–2 cm wide and 1–2 cm long, more or less horizontal, moderately to frequently branched, with short, radial branching sutures, surface aeruginous green when fresh, with slight concentric colour zonation, with distinct, involute, light greenish-grey margins, becoming green-grey in the herbarium. Upper surface more or less even when fresh, undulate-rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light grey in the herbarium. Thallus in section 150–200 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex collapsed-compacted, formed by a 30–50 µm thick layer of loosely packed, irregularly arranged, 4–6 µm thick hyphae; photobiont layer 50–100 µm thick, aeruginous-green; medulla 50–70 µm thick, hydrophobic; clamp

connections absent but lower medullary hyphae with numerous papilliform, coralloid hyphae 2–3 μm thick. Hymenophore corticioid, composed of resupinate, rounded to elongate patches 0.3–0.7 mm long and 0.3–3 mm broad, with cream-coloured to light yellowish, smooth surface and thin, involute, pilose margins; hymenophore in section 80–120 μm thick, supported by a thickened medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 $\times$ 5–7 μm ; basidia 25–35 $\times$ 5–5 μm , 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: MEXICO. Oaxaca: Santiago Comaltepec, Cerro Las Antenas; 17°35'N, 96°27'W, 2190 m; 17 May 2015, Moncada & Pérez 10288 (EB-BUAP **holotype**; B **isotype**).

Distribution and ecology: Mixed tropical-temperate cloud forest in southern Mexico, thus far only known from the type locality in Oaxaca, growing terrestrial between and over bryophytes.

Notes: This species is similar in morphology to a handful of medium-sized, epiphytic species, also featuring aeruginous-green lobes when fresh, such as *C. boleslia* from Bolivia (see above), *C. canari* from Ecuador (see above), *C. smaragdina* from Costa Rica (see below), *C. verjonensis* from Colombia (see below), and *C. viliewoa* from Costa Rica (see below). Apart from the epiphytic growth habit of all these taxa, *C. smaragdina* has in part thinly pilose lobes, whereas the lobes of *C. canari* are strongly concentrically undulate. *Cora boleslia* has less branched lobes and *C. viliewoa* differs in the more strongly bluish, thinner thallus; *C. verjonensis* is overall most similar to *C. dulcis* but its hymenophore consists of much larger, completely adnate, emarginate, soon confluent patches.

***Cora elephas* Lücking, Moncada & L. Vargas spec. nov.**

Index Fungorum: 552408; **Faces Of Fungi:** 02563; Fig. 6I, J

Etymology: The epithet refers to the grey colour and elephant skin-like consistency of this species. Elephants are also known as symbols of strength, authority, and leadership, being wise and thoughtful and with a good memory; perfect words to describe the impact and legacy of David Hawksworth in mycology and lichenology.

Holotype: Lücking & Moncada 34106 (UDBC).

ITS barcoding sequences: KJ780448 (holotype), KJ780396, KJ780406, KJ780410, KJ780413, KJ780415, KJ780418, KJ780419, KJ780422, KJ780424, KJ780425, KJ780450, KJ780451, KJ780454, KJ780455, KJ780456, KJ780497, KJ780499 (paratypes).

Diagnosis: A large *Cora* with mostly saxicolous thalli consisting of few, rather thick lobes with grey colour when fresh and very thick, white margins.

Thallus mostly saxicolous but usually associated with bryophytes and other lichens, if terricolous then adjacent to rocks, in exposed microsites, foliose, up to 20 cm across, composed of 3–7 semicircular, adjacent to subimbricate lobes; individual lobes 3–7 cm wide and 2–5 cm long, sparsely to moderately branched, without radial branching sutures, surface rather dark (brownish) grey when fresh, with slight concentric colour zonation or often mottled with light grey patches towards the center, with thick, involute, white margins, becoming yellowish grey in the herbarium and with a reddish tinge upon rewetting. Upper surface even to shallowly undulate or sometimes pitted when fresh, undulate to pitted when dry, glabrous; involute margins finely but distinctly pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming pale yellowish grey in the herbarium. Thallus in section 300–500 μm thick, with upper cortex, photobiont layer, and medulla; upper cortex distinctly viaduct-shaped, formed by a 30–50 μm thick layer of densely packed, more or less periclinal, 4–6 μm thick hyphae supported by a 70–100 μm high ‘medullary’ layer of spaced groups of anticlinal, 4–6 μm thick hyphae, separated from the photobiont layer by a layer of densely packed, anticlinal, brown hyphae; photobiont layer 100–200 μm thick, orange above, aeruginous-green below; medulla 100–150 μm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as elongate to linear, resupinate patches forming irregular to concentric lines, patches 1–2 mm long and 1–15 mm broad, with cream-coloured, smooth surface and felty, involute margins; hymenophore in section 100–120 μm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–35 $\times$ 4–5 μm ; basidia 25–35 $\times$ 4–5 μm , 4-sterigmate; basidiospores not observed. Chemistry: Producing a reddish pigment upon rewetting.

Material examined: COLOMBIA. Distrito Capital: Bogotá, paramo of Sumapaz; 04°17'N, 74°13'W, 3730 m; 3 December 2011, Lücking & Moncada 34106 (UDBC **holotype**; B, F **isotypes**); *ibid.*, Lücking & Moncada 34108, 34109, 34114, 34115, 34116 (B, UDBC **paratypes**); *ibid.*; 3700 m; 15 August 2010, Lücking & Moncada 32702, 32707, 32711, 32713, 32716, 32717, 32720, 32722, 32723 (B, UDBC **paratypes**). Cundinamarca: Villa Pinzón, paramo of Guacheneque; 05°13'N, 73°32'W, 3335 m; 15 May 2012, Moncada & Suárez 5418, 5421 (B, UDBC **paratypes**). ECUADOR. Azuay: Cuenca, paramo of Almohadillas; 03°02'S, 79°13'W, 3875 m; 26 June 2009, Nugra 865 (B, HA **paratypes**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes (Colombia, Ecuador), growing mostly saxicolous but usually associated with bryophytes and other lichens in exposed microsites. The species is by far

most abundant in the paramo of Sumapáz near Bogotá and is apparently absent from other well-studied paramos in Colombia except Guacheneque, and is also known with a single but rather typical collection from Ecuador.

Notes: *Cora elephas* is one of the largest and most conspicuous species of the genus, next to *C. ciferri* (Lücking et al. 2014c). The morphology with rather thick, large, dark grey lobes with thick, white margins, together with the predominant growth on rocks, makes this species relatively easy to recognize.

Cora fuscodavidiana Lücking, Moncada & L. Vargas **spec. nov.**

Index Fungorum: 552409; *Faces Of Fungi:* 02564; Fig. 6K

Etymology: The name is a combination of the Latin word *fuscus*, referring to the brown colour of the species, with the personal name David.

Holotype: Lücking & Moncada 32708 (UDBC).

ITS barcoding sequence: KJ780411 (holotype).

Diagnosis: A small, saxicolous *Cora* characterized by a macrosquamulose, olive-brown thallus consisting of numerous lobes with granulose to sorediate margins and scattered soredia formed on the lobe surface.

Thallus saxicolous but growing over mats of bryophytes and lichens, macrosquamulose, up to 2 cm across, composed of 10–30 semicircular, adjacent to subimbricate lobes; individual lobes 0.3–0.5 cm wide and 0.3–0.5 cm long, sparsely to moderately branched, without radial branching sutures, surface olive-brown when fresh, without concentric colour zonation, with thick, involute, olive-brown margins, becoming brownish grey in the herbarium. Upper surface uneven when fresh, rugose when dry, glabrous but with scattered soredia; involute margins granulose to sorediate; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), light olive-brown when fresh, becoming grey-brown in the herbarium. Thallus in section 250–350 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged to periclinal, 4–5 µm thick hyphae supported by a 30–50 µm high ‘medullary’ layer of spaced groups of anticlinal, 4–5 µm thick hyphae; photobiont layer 100–200 µm thick, orange-brown above, olive-green below; medulla 50–100 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Distrito Capital: Bogotá, paramo of Sumapaz; 04°17'N, 74°13'W, 3700 m; 15 August 2010, Lücking & Moncada 32708 (UDBC **holotype**; B, F, **isotypes**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes; only known from the type locality in

Colombia, growing saxicolous on bryophyte and lichen mats in shady microsites.

Notes: This new species is characterized by its small, olive-brown, marginally sorediate lobules, in combination with a saxicolous growth over bryophyte and lichen mats. It is phylogenetically related to *C. corellesia* (see above), *C. davicrinia* (see above) and *C. minor*, but differs in the dark, olive-brown surface colour and the substrate ecology.

Cora garagoa Simijaca, Moncada & Lücking **spec. nov.**

Index Fungorum: 552410; *Faces Of Fungi:* 02565; Fig. 6L, M

Etymology: The epithet refers to the type locality in Garagoa and the indigenous term

Garagoa (“Ga-ra-gua”) of the Chibcha people that originally inhabited the area, meaning “behind the hill”.

Holotype: Simijaca 2063 (UDBC).

ITS barcoding sequence: KX772578 (holotype).

Diagnosis: Differing from *Cora arcabucana* in the slightly larger size and lack of soredia, and from *C. pastorum* in the emerald-green color and viaduct-shaped cortex.

Thallus epiphytic on branches and twigs, foliose, up to 5 cm across, composed of 3–5 semicircular, adjacent to subimbricate lobes; individual lobes 1–3 cm wide and 1–2 cm long, ascending, moderately branched, with rather distinct, long, radial branching sutures, surface emerald-green when fresh, without concentric colour zonation, with thin, involute, cream-colored margins, becoming grey in the herbarium. Upper surface very shallowly undulate when fresh, shallowly undulate when dry, thinly pilose especially in a broad concentric band towards the margins; involute margins pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), green-grey when fresh, becoming light grey in the herbarium. Thallus in section 250–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–30 µm thick layer of densely packed, more or less periclinal, 4–6 µm thick hyphae supported by a 50–80 µm high ‘medullary’ layer of irregularly arranged to anticlinal, 4–6 µm thick hyphae, with emerging setae formed by tufts of agglutinate hyphae, setae 100–150 µm long and 15–25 µm broad at the base; photobiont layer 80–120 µm thick, olive-green (upper portion) to aeruginous-green (lower portion); medulla 50–100 µm thick; clamp connections absent but lower medullary hyphae with numerous papilliform, short, unbranched to basally branched hyphae 2–3 µm thick. Hymenophore corticioid, developed as rounded to irregular, completely adnate and emarginate patches soon becoming confluent and covering large areas of the lower surface, patches at first 0.5–1 mm diam., when confluent up to 10 mm across, with white, smooth surface; hymenophore in section 40–

50 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 20–25 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Boyacá: Garagoa, Vereda Cienega Valvanera, El Secreto private reserve; 05° 08'N, 73°17'W, 2180 m; 12 June 2014, Simijaca 2063 (UDBC **holotype**; **B isotype**).

Distribution and ecology: Only known from the type locality, growing epiphytically in montane rain forest.

Notes: This species is most similar to *Cora pastorum* (see below) in morphology and substrate ecology, but the latter has an olive-green color when fresh and a collapsed-compacted cortex. The closely related *C. arcabucana* (see above) is slightly smaller in size and produces soredia.

***Cora gigantea* Lücking, Moncada & Coca spec. nov.**

Index Fungorum: 552411; **Faces Of Fungi:** 02566; Fig. 6N, O

Etymology: The name refers to the large thallus and lobe size of this species, but also honors David as a giant in mycology and lichenology.

Holotype: Lücking & Moncada 35344 (UDBC).

ITS barcoding sequence: KJ780515 (holotype).

Diagnosis: A very large *Cora* growing terrestrial between rocks and associated with bryophytes and other lichens, with large, rather thin and flexible, light aeruginous-grey, zoned lobes with thin but distinct, white margins when fresh.

Thallus terricolous or subepiphytic, associated with bryophyte and lichen mats, foliose, up to 30 cm across, composed of 3–5 semicircular, adjacent to subimbricate lobes; individual lobes 5–8 cm wide and 5–10 cm long, moderately to frequently branched and with indistinct, short, radial branching sutures, surface light aeruginous grey when fresh, with concentric colour zonation, with thin but distinct, involute, white margins, becoming pale yellowish grey in the herbarium. Upper surface even to shallowly pitted towards the margins when fresh, rugose to shallowly pitted when dry, glabrous; involute margins finely pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming pale yellowish white in the herbarium. Thallus in section 350–450 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–30 µm thick layer of densely packed, more or less periclinal, 4–6 µm thick hyphae supported by a 50–100 µm high 'medullary' layer of spaced groups of anticlinal, 4–6 µm thick hyphae; photobiont layer 100–180 µm thick, orange-olive above, aeruginous below; medulla 100–150 µm thick, upper portion hydrophobic; clamp connections absent, papilliform hyphae absent. Hymenophore

Fig. 7 **A** *Cora gomeziana* (holotype). **B, C** *C. guajalensis* (**B** holotype; **C** isotype, underside with hymenophore). **D, E** *C. hafecesweorthensis* (isotype, in **D** rewetted, in **E** underside with hymenophore). **F, G** *C. haledana* (isotype, in **F** rewetted, in **G** section through lower medulla with papilliform hyphae). **H–J** *C. hawksworthiana* (**H, J** Moncada 4604a, in **H** rewetted; **I** Moncada 5452). **K–M** *C. hochesuordensis* (isotype, in **K** rewetted, in **M** underside with hymenophore). **N, O** *C. hymenocarpa* (**N** Dal Forno 1769; **O** isotype). Scale = 10 mm, in **M** = 5 mm

cyphelloid, developed as elongate, resupinate patches forming short, concentrically arranged lines, patches 5–12 mm long and 10–50 mm broad, with whitish to cream-coloured, smooth surface and setose, involute margins; hymenophore in section 80–100 µm thick, supported by a massive medullary layer composed of mostly anticlinal hyphae; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 5–6 µm; basidia 25–35 × 4–5 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: Junín, Bosques Peña de Santa Bárbara Natural Reserve; 04°49'N, 73°45'W, 2520 m; 11 November 2012, Lücking & Moncada 35344 (UDBC **holotype**; **B, F, I** isotypes). Meta: El Calvario, Distrito San Francisco; 04°23'N 73°46'W, 2424 m; 14 January 2014, Coca et al. 3845 (FAUC **paratype**).

Distribution and ecology: Montane cloud forest zone around 2500 m; growing terricolous or subepiphytically between bryophyte and lichen mats.

Notes: *Cora gigantea* is the largest species of *Cora* known thus far. It superficially resembles *C. elephas* (see above) but is even larger and differs in the thinner, more flexible thallus with light aeruginous-grey colour. *Cora gigantea* takes a basal position in a large clade including the often common and rather widespread species, *C. accipiter* (see above), *C. arachnoidea*, *C. cyphellifera*, *C. dewisanti* (see above), and *C. elephas*, among others.

***Cora gomeziana* Dal Forno, Chaves & Lücking spec. nov.**

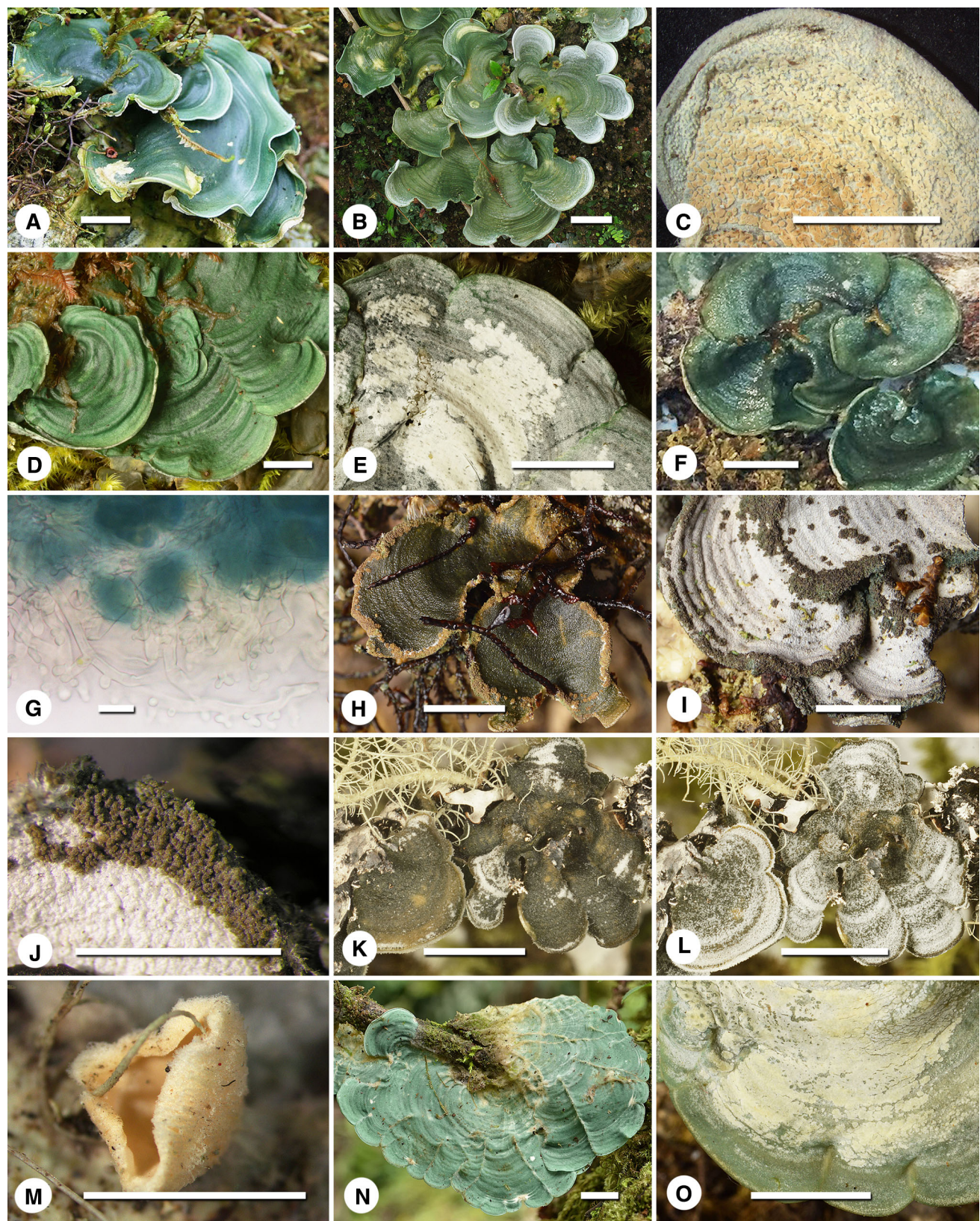
Index Fungorum: 552412; **Faces Of Fungi:** 02567; Fig. 7A

Etymology: This species is dedicated to the great Costa Rican biologist, former colleague and friend, the late Luis Diego Gómez P. (Monge-Nájera et al. 2010), who first studied basidiolichens in Costa Rica (Gómez 1972), at the time applying the name *Cora pavonia* to what is now recognized as a new taxon in his honour.

Holotype: Dal Forno 1703 (CR).

ITS barcoding sequence: KJ780598 (holotype).

Diagnosis: A large, terrestrial, aeruginous-green species with cyphelloid hymenophore, forming a reddish pigment when rewetting herbarium specimens.



Thallus terrestrial, on soil on slope between bryophytes, foliose, up to 6 cm across, composed of 2–5 semicircular, imbricate lobes; individual lobes 3–6 cm wide and 2–5 cm long, sparsely branched, without radial branching sutures, surface aeruginous-green when fresh, with slight concentric colour zonation, with thin, involute, light green-grey margins, becoming light grey in the herbarium but producing a reddish pigment when rewetting. Upper surface even when fresh, somewhat undulate when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla) to densely setose, white when fresh, becoming grey in the herbarium. Thallus in section 330–370 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–25 µm thick layer of densely packed, periclinal, 2–3 µm thick hyphae supported by a 45–80 µm high ‘medullary’ layer of spaced groups of more densely packed, anticlinal, 3–5 µm thick hyphae; photobiont layer 130–160 µm thick, aeruginous-green; medulla 110–140 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore cyphelloid, developed as rounded to irregular, sessile patches, more or less flattened or resembling a calix, often protruding beneath the lobes, patches 1–2.5 mm across, with cream-coloured, smooth surface and felty, involute margins; hymenophore in section 300–350 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: Producing a reddish pigment upon rewetting.

Material examined: COSTA RICA. Cartago: Tapantí National Park, Tres de Junio; 09°40'N, 83°51'W, 2700 m; disturbed upland peat bog with scattered shrubs and *Blechnum*; 21 May 2012, Dal Forno 1703 (CR **holotype**; GMUF **isotype**).

Distribution and ecology: Known only from the type locality near Cerro de la Muerte in Costa Rica, on a very wet slope of a bog surrounded by subandine forest, growing on soil amongst bryophytes and ground dwelling angiosperms, surrounded by other decaying *Cora* lobes.

Notes: This is one of several species in the *Cora elephas* clade (see above), which all species in this clade turning reddish when rewetting herbarium material, such as *C. rubrosanguinea* (see below). *Cora gomeziana* differs from these species by the aeruginous-green thallus colour when fresh, the rather thin lobe margins, and the protruding hymenophore.

***Cora guajalitensis* Lücking, Robayo & Dal Forno spec. nov.**

Index Fungorum: 552413; **Faces Of Fungi:** 02568; Fig. 7B, C

Etymology: Referring to the type locality.

Holotype: Lücking 26201 (QCNE).

ITS barcoding sequence: KF443239 (holotype).

Diagnosis: A mid-sized, terrestrial *Cora* growing close to the ground, with ascending, grey-green lobes when fresh and with a dense hymenophore formed by irregular to elongate, partly confluent, flat patches with rounded ends, with diffusely concentric arrangement.

Thallus terricolous, growing directly on the ground, associated with bryophytes, foliose, up to 15 cm across, composed of 10–20 semicircular, adjacent to subimbricate lobes; individual lobes 1–3 cm wide and 1–5 cm long, moderately to frequently branched, without distinct, radial branching sutures, surface grey-green when fresh, with slight concentric colour zonation, with thin, involute, light grey-green margins, becoming white-grey in the herbarium. Upper surface shallowly undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming grey in the herbarium. Thallus in section 150–200 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 10–20 µm thick layer of densely packed, more or less periclinal, 4–5 µm thick hyphae supported by a 20–30 µm high ‘medullary’ layer of spaced groups of irregularly arranged to anticlinal, 4–5 µm thick hyphae; photobiont layer 70–100 µm thick, olive-green above, aeruginous-green below; medulla 30–50 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as rounded to irregular to elongate, often anastomosing, resupinate patches with rounded ends forming diffusely concentric lines, patches 0.3–0.7 mm long and 0.3–1.5 mm broad, with cream-coloured, smooth surface and indistinct margins; hymenophore in section 80–100 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: ECUADOR. Pichincha: Río Guajalito Protected Forest; 00°09'S, 78°39'W, 1800 m; 2 September 2008, Lücking 26201 (QCNE **holotype**; B **isotype**).

Distribution and ecology: Only known from the type locality, growing on the ground on an open road bank in a montane rain forest, associated with mosses and other lichens.

Notes: This species belongs in the *Cora reticulifera* clade (Lücking et al. 2014b), which mostly contains species growing directly on soil, often with completely adnate lobes and with a well-developed, in most species reticulate hymenophore. Within this clade, *C. guajalitensis* is characterized by the ascending lobes that are not closely

appressed to the ground, and the grey-green colour when fresh.

Cora hafecesweorthensis Moncada, Lücking & R. Peláez **spec. nov.**

Index Fungorum: 552414; *Faces Of Fungi*: 02569; Fig. 7D, E

Etymology: The epithet refers to one of two English places on which the surname Hawksworth is based, ‘Hafecesweorthe’ in Yorkshire, which means ‘Hafoc’s settlement’, the given name ‘Hafoc’ meaning hawk (see also under *Cora accipiter*).

Holotype: Lücking & Moncada 35424 (UDBC).

ITS barcoding sequence: KJ780519 (holotype).

Diagnosis: A rather large, terrestrial *Cora* with aeruginous-green to emerald-green, undulate lobes and a hymenophore forming large, completely adnate, flat, emarginate spots.

Thallus terrestrial between bryophytes and other lichens (*Peltigera* sp.), foliose, up to 20 cm across, composed of 5–10 semicircular, adjacent to subimbricate lobes; individual lobes 3–8 cm wide and 3–5 cm long, sparsely to moderately branched and with long, radial branching sutures, surface aeruginous-green to emerald-green when fresh, without concentric colour zonation, with thin, involute, whitish margins, becoming light greenish to bluish grey with colour zonation in the herbarium. Upper surface undulate when fresh, undulate and shallowly pitted in parts when dry, glabrous; involute margins glabrous; lower surface ecorticate, thinly felty-arachnoid (representing the exposed medulla), light greenish grey when fresh, becoming yellowish grey in the herbarium. Thallus in section 120–150 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 10–20 µm thick layer of densely packed, periclinal, 4–5 µm thick hyphae supported by a 20–30 µm high ‘medullary’ layer of spaced groups of irregularly arranged to anticlinal, 4–5 µm thick hyphae; photobiont layer 40–60 µm thick, aeruginous; medulla 30–50 µm thick; clamp connections absent but lower medullary hyphae with numerous, papilliform, globose to coralloid hyphae 3–4 µm thick. Hymenophore corticioid, developed as rounded to irregular, completely adnate and emarginate patches soon becoming confluent and covering large areas of the lower surface, patches at first 1–3 mm long and 1–5 mm broad, when confluent up to 30 mm diam., with cream-white, smooth surface; hymenophore in section 40–50 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 20–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: Junín, Bosques Peña de Santa Bárbara Natural Reserve; 04°49'N,

73°45'W, 2520 m; 11 November 2012, Lücking & Moncada 35424 (UDBC **holotype**; B, F **isotypes**).

Distribution and ecology: Wet subparamo and subandine cloud forest zone between 2500 and 3000 m; only known from the type locality in Colombia, growing terrestrial between bryophytes and other lichens, including *Peltigera* sp., in a shaded microsite.

Notes: *Cora hafecesweorthensis* is a rather large, terrestrial species akin towards *C. ciferrii* (Lücking et al. 2014c). The latter also has concentrically undulate lobes, but differs in the olive-brown to grey-brown colour when fresh and the differently shaped hymenophore. The completely adnate, emarginate hymenophore of *C. hafecesweorthensis* is unique among the genus, forming one extreme in a series of morphological transitions towards a sessile, cyphelloid hymenophore as found, for example, in *C. cyphellifera* (Lücking et al. 2013a).

Cora haledana Dal Forno, Chaves & Lücking **spec. nov.**

Index Fungorum: 552415; *Faces Of Fungi*: 02570; Fig. 7F, G

Etymology: The epithet is an anagram of David’s name in reverse (Hawksworth Leslie David).

Holotype: Dal Forno 1715 (CR).

ITS barcoding sequence: KJ780607 (holotype).

Diagnosis: A medium-sized, epiphytic paramo species with green lobes and even surface, as well as medullary papillae, differing from *Cora viliewoa* in the absence of a bluish tinge and in the thicker thallus.

Thallus epiphytic, foliose to macrosquamulose, up to 4 cm across, composed of 5–10 semicircular, adjacent to subimbricate lobes; individual lobes 1–2 cm wide and 0.6–1 cm long, moderately branched and with short, radial branching sutures, surface dark green when fresh, without concentric colour zonation, with thin, involute, green margins, becoming uniformly grey in the herbarium. Upper surface even when fresh, and slightly rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), light green-grey when fresh, becoming grey in the herbarium. Thallus in section 250–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex collapsed-compacted, formed by an 80–110 µm thick layer of loosely packed, irregularly arranged, 3–6 µm thick hyphae; photobiont layer 60–140 µm thick, aeruginous-green; medulla 26–90 µm thick; clamp connections absent but lower medullary hyphae with numerous papilliform, unbranched to branched hyphae 3–6 µm thick. Hymenophore not observed.

Material examined: COSTA RICA. San José: Los Santos Forest Reserve, Cerro de la Muerte; 09°34'N, 83°45'W, 3400–3500 m; 21 May 2012, Dal Forno 1715 (CR **holotype**; GMUF **isotype**).

Distribution and ecology: Known only from the type locality at Cerro de la Muerte in Costa Rica, growing epiphytically on tree branches and twigs in the paramo.

Notes: *Cora haledana* agrees in substrate ecology, size and colour with a number of other species, including *C. boleslia*, *C. canari* (see above), *C. santacruzensis*, *C. smaragdina*, *C. suturifera*, *C. udebeceana*, *C. verjonensis*, and *C. viliewoa* (see below). Among these, only *C. boleslia*, *C. viliewoa*, and *C. santacruzensis* feature lower medullary papillae, and the first two agree with *C. haledana* also in the more or less even thallus surface, whereas in *C. santacruzensis* it is shallowly undulate. *Cora boleslia* differs in the viaduct-shaped cortex from both *C. haledana* and *C. viliewoa*, and the latter, like *C. haledana* from Costa Rica but a lower altitude montane rain forest species, differs only in the distinctly bluish tinge of the fresh colour and the thinner thallus. These two and the aforementioned species are not closely related (Fig. 2; Online Supplement D).

Cora hawksworthiana Dal Forno, P. Nelson & Lücking spec. nov.

Index Fungorum: 552416; *Faces Of Fungi*: 02571; Fig. 7H–J

Etymology: This morphologically and ecogeographically most remarkable species is dedicated to David Hawksworth on the occasion of his seventieth birthday, for his innumerable contributions to mycology.

Holotype: Dal Forno 1708 (CR).

ITS barcoding sequence: KJ780600 (holotype), KJ780503, KJ780466, KX772638, KX772639, KX772640, KX772641, KX772642, KX772643, KX772644, KX772645, KX772727 (paratypes).

Diagnosis: A small to medium-sized, epiphytic *Cora* with abundant, marginal and laminal soredia and marked colour contrast between fresh and dry lobes: fresh lobes with dark olive colour and light brown soredia and dry lobes with white–grey colour and dark olive soredia.

Thallus epiphytic on branches of shrubs and trees, sometimes overgrowing bryophytes (*Frullania* spp.) or very rarely on soil (Nelson 4835), foliose, up to 5 cm across, composed of 3–8 semicircular, adjacent to subimbricate lobes; individual lobes 0.7–3 cm wide and 0.7–2 cm long, sparsely to moderately branched, without or with short, radial branching sutures, surface dark olive when fresh, without concentric colour zonation, with distinct, involute, cream-coloured margins covered by light brown soredia, becoming white–grey in the herbarium with the soredia becoming dark olive. Upper surface even to very shallowly undulate when fresh, undulate-rugose when dry, glabrous but with concentric bands of scattered to dense soredia; involute margins glabrous, densely sorediate; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light grey

in the herbarium. Thallus in section 200–350 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 20–40 µm thick layer of rather densely packed, irregularly arranged, 4–6 µm thick hyphae supported by a 40–80 µm high ‘medullary’ layer of spaced groups of irregularly arranged, 4–6 µm thick hyphae; photobiont layer 70–120 µm thick, orange-brown, soredia aeruginous-green; medulla 50–100 µm thick; clamp connections absent but lower medullary hyphae with numerous papilliform, unbranched to branched hyphae 3–4 µm thick. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COSTA RICA. Cartago: Tapantí National Park, Tres de Junio, Cerro de la Muerte; 09°34'N, 83°45'W, 3300–3400 m; 21 May 2012, Dal Forno 1708 (CR **holotype**; GMUF **isotype**). COLOMBIA. Cundinamarca: Choachí, Matarredonda Ecological Park, El Verjón; 04°33'N, 74°00'W, 3220 m; 23 January 2011, Moncada 4604a (B, UDBC **paratypes**). COLOMBIA. Cundinamarca: Villa Pinzón, paramo of Guacheneque; 05°13'N, 73°32'W, 3335 m; 15 May 2012, Moncada & Suárez 5452 (B, UDBC **paratypes**). Cauca: Inzá, paramo of Guanacas-Las Delicias; 02°30'N, 76°14'W, 3330 m; 16 October 2013, Moncada 7191 (UDBC **paratype**). CHILE. Los Ríos: La Reserva Costera Valdiviana; 40°06'S, 73°31'W, 884 m; 17 January 2012, Nelson 4699 (hb. Nelson **paratype**); *ibid.*, 40°05'S, 73°32'W, 823 m; 19 January 2012, Nelson 4835 (hb. Nelson **paratype**); *ibid.*, 39°59'S, 73°36'W, 335 m; 20 January 2012, Nelson 4874 (hb. Nelson **paratype**). Parque Nacional Puyehue; 40°42'S, 72°08'W, 576 m; 25 January 2012, Nelson 5461 (hb. Nelson **paratype**); *ibid.*, 40°37'S, 72°09'W, 975 m; 28 January 2012, Nelson 6074, 7345 (hb. Nelson **paratype**). Aysén del General Carlos Ibáñez del Campo: Reserva Nacional Río Simpson; 45°29'S, 72°15'W, 178 m; 2 February 2012, Nelson 6252 (hb. Nelson **paratype**). Parque Nacional Queulat; 44°28'S, 72°32'W, 300 m; 9 February 2012, Nelson 6675 (hb. Nelson **paratype**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes (Colombia) and southern Central America (Costa Rica), as well as in subalpine to temperate rain forest regions in Chile, growing mostly epiphytically on twigs of shrubs and small trees in shaded to semi-exposed conditions. *Cora hawksworthiana* forms a remarkable exception to the pattern found in almost all other species of the genus, which seem to be mostly regionally to locally restricted (Lücking et al. 2014b). Whether this is connected to the ability to disperse via soredia needs to be tested. Another possible explanation is that speciation is much slower in clades reproducing vegetatively, but this is not supported by the case of *C. minor* and *C. paraminor* (see below).

Notes: *Cora hawksworthiana* is a very characteristic and easily recognized species, due to the heavily sorediate

margins and the formation of concentric bands of soredia also on the lobe surface. The colour contrast between fresh and dry thalli is also remarkable, with the soredia being lighter than the lobe surface in the hydrated stage and becoming much darker in the herbarium. The species is most closely related to *C. canari* (see above) and *C. minutula* (see below).

***Cora hochesuordensis* Lücking, E. Morales & Dal Forno spec. nov.**

Index Fungorum: 552417; *Faces Of Fungi*: 02572; Fig. 7K–M

Etymology: The Anglo-Saxon surname Hawksworth is presumably derived from two places in England, one of them first recorded under the name ‘Hochesuorde’ in the 11th century and here taken up as epithet.

Holotype: Lücking 29363 (HCUCB-452).

ITS barcoding sequences: KJ780367, KJ802415 (both holotype, the latter obtained through 454 pyrosequencing).

Diagnosis: A small, epiphytic *Cora* with dark olive-brown thallus furnished with concentric bands and irregular patches of white setae and with distinctly pilose margins, as well as a cyphelloid hymenophore.

Thallus epiphytic on twigs of shrubs, foliose, up to 5 cm across, composed of 3–5 semicircular, adjacent lobes; individual lobes 0.5–1.5 cm wide and 0.5–1 cm long, sparsely to moderately branched and with distinct, radial branching sutures, surface olive-brown when fresh, with irregular to concentric colour zonation due to concentric bands and irregular patches of white setae, with distinct, involute, whitish margins, becoming light grey in the herbarium. Upper surface shallowly undulate when fresh, rugose when dry, with concentric bands and irregular patches of white, arachnoid setae; involute margins distinctly pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), light bluish grey when fresh, becoming grey in the herbarium. Thallus in section 250–350 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 20–50 µm thick layer of loosely packed, irregularly arranged, 4–6 µm thick hyphae supported by a 50–100 µm high ‘medullary’ layer of spaced groups of anticlinal, 4–6 µm thick hyphae, upper layer with emergent setae formed by agglutinate hyphae, setae 100–180 µm long and 15–30 µm thick at the base; photobiont layer 70–120 µm thick, olive-orange above, aeruginous-green below; medulla 30–70 µm thick; clamp connections absent but lowermost medullary hyphae with numerous, papilliform, unbranched to branched hyphae 2–3 µm thick. Hymenophore cyphelloid, developed as rounded to irregular, sessile patches resembling a calix, patches 2–3 mm long and 2–5 mm broad, with cream-coloured, smooth surface and felty, involute margins; hymenophore in section 80–100 µm

thick, supported by a thick medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: BOLIVIA. Cochabamba: Chapare, Corani Reservoir; 17°16'S, 65°54'W, 3260 m; 7 July 2009, Lücking 29363 (HCUCB-452 **holotype**; B **isotype**).

Distribution and ecology: Only known from the type locality growing epiphytically on twigs of shrubs in the andine puna.

Notes: *Cora hochesuordensis* is a rather inconspicuous species, characterized by a small thallus with hairy lobes and a cyphelloid hymenophore. It is rather closely related to *C. elephas* (see above), which has a quite different morphology and ecology. The more distantly related *C. cyphellifera* has a similar hymenophore, but a much larger, glabrous thallus with is light aeruginous when fresh (Lücking et al. 2013a).

***Cora hymenocarpa* Lücking, Chaves & Lawrey spec. nov.**

Index Fungorum: 552418; *Faces Of Fungi*: 02573; Fig. 7N, O

Etymology: The epithet refers to the strongly flattened, emarginate hymenophore.

Holotype: Lücking s.n. (CR).

ITS barcoding sequence: EU825959 (holotype), KJ780616, KJ780618 (paratypes).

Diagnosis: A very large, epiphytic *Cora* with light grey-green to aeruginous-grey lobes when fresh, frequently branched and with distinct radial branching sutures, with concentrically undulate surface and completely adnate, spot-like, emarginate hymenophore.

Thallus epiphytic on twigs and branches of trees and shrubs, foliose, up to 20 cm across, composed of 1–3 semicircular, adjacent to subimbricate lobes; individual lobes 5–15 cm wide and 5–10 cm long, frequently branched and with long, distinct, radial branching sutures, surface light grey-green to aeruginous-grey when fresh, with slight concentric colour zonation, with thin, involute, green-grey margins, becoming grey in the herbarium. Upper surface undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous but becoming setose along the sutures; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), grey-green when fresh, becoming yellowish grey in the herbarium. Thallus in section 150–200 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–30 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae supported by a 30–50 µm high ‘medullary’ layer of spaced groups of irregularly arranged to anticlinal, 4–6 µm thick hyphae;

photobiont layer 50–100 µm thick, aeruginous; medulla 30–50 µm thick; clamp connections absent but lower medullary hyphae with papilliform, coralloid hyphae 2–3 µm thick. Hymenophore corticioid, developed as rounded to irregular, completely adnate and emarginate patches soon becoming confluent and covering large areas of the lower surface, patches at first 0.5–1 mm long and 1–5 mm broad, when confluent up to 20 mm diam., with cream-white, smooth surface; hymenophore in section 80–100 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COSTA RICA. Puntarenas: Las Cruces Biological Station; 08°47'N, 82°57'W, 1210 m; 22 September 2007, Lücking s.n. (CR **holotype**; B **isotype**); *ibid.*, 28 May 2012, Dal Forno 1766a, 1769 (CR. GMUF **paratypes**).

Distribution and ecology: Known only from southern Costa Rica; a tropical montane rain forest species growing epiphytically on twigs and branches of shrubs and trees in shaded to semi-exposed situations.

Notes: *Cora hymenocarpa* is very similar to *C. hafecsesweorthensis* from Colombia (see above), both representing rather large species with greenish, concentrically undulate lobes and a completely adnate, emarginate hymenophore forming large, confluent spots. The differences are mainly in substrate ecology, with the latter being terrestrial, and colour, the latter having a bright emerald-green thallus when fresh. The two species are, however, only very distantly related (Lücking et al. 2014b), separated by several morphologically deviating clades, another striking example of parallelism in phenotype features, as known in *Graphidaceae* and *Lobariaceae* (Rivas Plata and Lumbsch 2011; Moncada et al. 2013, 2014a, b).

***Cora imi* Lücking, Chaves & Lawrey spec. nov.**

Index Fungorum: 552419; **Faces Of Fungi:** 02574; Fig. 8A, B

Etymology: The epithet, here used as an acronym noun in apposition, refers to the former International Mycological Institute (IMI), originally established as the Imperial Bureau of Mycology in Kew and now part CAB International. David Hawksworth was director of the IMI from 1983 to 1997 and oversaw both its name change Commonwealth Mycological Institute in 1986 and its move from Kew to Egham in 1993 (Aitchison and Hawksworth 1993); the collections were eventually moved back to Kew in 2009.

Holotype: Lücking 15581 (CR).

ITS barcoding sequences: EU825958 (holotype).

Diagnosis: A large, terrestrial *Cora* with concentrically undulate, emerald-green lobes and concentric to reticulate, resupinate hymenophore.

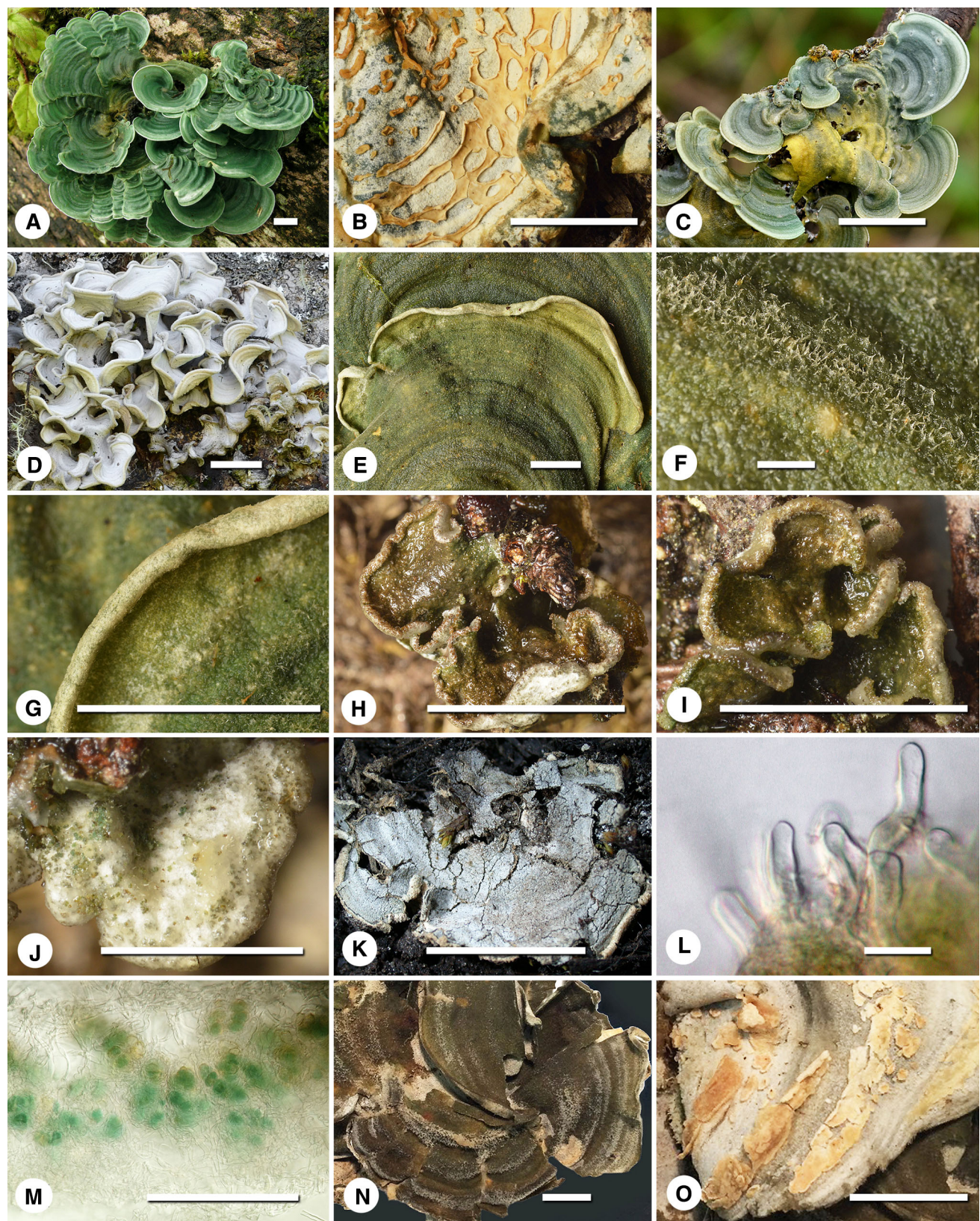
Fig. 8 A, B *Cora imi* (A field image; B isotype, underside with hymenophore). C *C. itabaiana* (holotype). D *C. leslactuca* (holotype). E–G *C. maxima* (isotype, rewetted). H–J *C. minutula* (isotype, in H rewetted, in J underside). K, L *C. palaeotropica* (isotype, in L section through upper portion showing absence of cortex and erect hyphae). M *C. palustris* (holotype, section through thallus showing more or less collapsed cortex). N, O *C. parabovei* (isotype, in N rewetted, in O underside with hymenophore). Scale = 10 mm, in F = 1 mm, in J = 5 mm, in L = 10 µm

Thallus terrestrial between bryophytes or rarely on rotten logs, foliose, up to 25 cm across, composed of 5–15 semicircular, subimbricate lobes; individual lobes 5–10 cm wide and 3–7 cm long, sparsely to moderately branched and with long, radial branching sutures, surface emerald-green when fresh, with slight concentric colour zonation, with thin, involute, grey-white margins, becoming yellowish grey in the herbarium. Upper surface undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming yellowish grey in the herbarium. Thallus in section 250–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex distinctly viaduct-shaped, formed by a 20–30 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae supported by a 50–80 µm high ‘medullary’ layer of irregularly arranged to anticlinal, 4–6 µm thick hyphae; photobiont layer 70–120 µm thick, aeruginous; medulla 30–70 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as irregular to elongate or linear, resupinate patches forming concentric, anastomosing and reticulate lines, patches 0.5–2 mm long and 1–10(–30) mm broad, with pale orange, smooth surface and rough, involute margins; hymenophore in section 80–110 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 5–7 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COSTA RICA. San José: Los Santos Forest Reserve, Cerro de la Muerte; 09°34'N, 83°45'W, 3400–3500 m; 4 Juli 2002, Lücking 15581 (CR **holotype**; B **isotype**).

Distribution and ecology: Wet Central American paramos above 3000 m, thus far only known from the type collection in Costa Rica, growing terrestrial between bryophytes.

Notes: *Cora imi* belongs in a morphological group of large, terrestrial species with more or less concentrically undulate lobes, including *C. ciferrii* (Lücking et al. 2014c), *C. dalehana* and *C. hafecsesweorthensis* (see above). *Cora imi* is rather closely related to *C. dalehana* (Lücking et al. 2014b), but differs in the green, more strongly and broadly undulate lobes. *Cora hafecsesweorthensis* also has green, strongly undulate lobes, but a very different, completely



adnate and emarginate hymenophore. The different distribution, with *C. dalehana* and *C. hafecesweorthensis* known from Colombia and *C. imi* from the rather isolated Costa Rican paramos, supports the notion of allopatric speciation.

Cora itabaiana Dal Forno, Aptroot & M. Cáceres **spec. nov.**

Index Fungorum: 552420; *Faces Of Fungi*: 02575; Fig. 8C

Etymology: The epithet, here used as a noun in apposition, refers to the type locality in the Serra de Itabaiana.

Holotype: Cáceres & Aptroot 18578 (ISE).

ITS barcoding sequence: KX772629, KX772630 (both holotype, the latter obtained through 454 pyrosequencing).

Diagnosis: A medium-sized, epiphytic species with grey-green color and viaduct-shaped cortex, lacking medullary papillae.

Thallus epiphytic, foliose, up to 4 cm across, composed of 8–15 semicircular, subimbricate lobes; individual lobes 0.5–1.5 cm wide and 0.5–1 cm long, frequently branched and with long, pilose, radial branching sutures, surface green-grey when fresh, with some concentric colour zonation, with thin, involute, light grey margins, becoming uniformly grey in the herbarium. Upper surface shallowly and broadly undulate when fresh, rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white when fresh, becoming grey in the herbarium. Thallus in section 250–350 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–25 µm thick layer of loosely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae supported by a 45–70 µm high ‘medullary’ layer of spaced groups of more densely packed, anticlinal, 4–7 µm thick hyphae; photobiont layer 100–140 µm thick, orange-green (upper portion) to aeruginous-green (lower portion); medulla 90–140 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed.

Material examined: BRAZIL. Sergipe: Município de Areia Branca, Serra de Itabaiana National Park; 10°45'S, 37°20'W, 220 m; lowland Atlantic rain forest, close to a stream; 18 September 2013, Cáceres & Aptroot 18578 (ISE **holotype**; ABL, GMUF **isotypes**).

Distribution and ecology: Known only from the type locality in the Atlantic rain forest biome in Sergipe state, Brazil, growing epiphytically at the base of a sapling in higher elevation, open ‘campos rupestres’ in the park. The discovery of this taxon in this rather unusual habitat suggests that other species might be found in Brejos de Altitude, high-altitude isolated Atlantic rain forest remnants in the Brazilian northeast.

Notes: *Cora itabaiana* is a fairly non-descript species, without any special character and with the hymenophore unknown. It differs from other species of similar substrate

ecology, size, and color, such as *C. pikynasa* and *C. yukiboa* (see below) by its yellowish green hue, the viaduct-shaped cortex (collapsed-compacted in *C. pikynasa*), and the absence of papillae (present in *C. yukiboa*).

Cora les lactuca Lücking, Moncada & R. Peláez **spec. nov.**

Index Fungorum: 552421; *Faces Of Fungi*: 02576; Fig. 8D

Etymology: The name is a combination of David’s second name, Leslie, and the genus name *Lactuca*, which includes the lettuce plant, *L. sativa*, since this *Cora* resembles salad leaves in habitus.

Holotype: Lücking & Moncada 35312 (UDBC).

ITS barcoding sequences: KJ780507 (holotype), KJ780524 (paratype).

Diagnosis: A mid-sized, saxicolous *Cora* forming numerous imbricate lobes with dark olive-grey surface when fresh and undulate, pilose margins, resembling a salad leaf.

Thallus saxicolous, foliose, up to 10 cm across, composed of 10–20 semicircular, imbricate lobes; individual lobes 1–2 cm wide and 0.7–1.5 cm long, moderately to frequently branched and with indistinct, radial branching sutures, surface (dark) olive-grey when fresh, with slight concentric colour zonation, with distinct, involute, cream-coloured margins, becoming light grey in the herbarium. Upper surface even to shallowly undulate when fresh, undulate-rugose when dry, glabrous; involute margins distinctly pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), cream-coloured when fresh, becoming yellowish in the herbarium, with areas of thicker, spongy, ochraceous tomentum towards the thallus center. Thallus in section 450–550 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex distinctly viaduct-shaped, formed by a 30–50 µm thick layer of densely packed, irregularly arranged to periclinal, 4–5 µm thick hyphae supported by a 50–80 µm high ‘medullary’ layer of anticlinal, 4–5 µm thick hyphae; photobiont layer 150–250 µm thick, orange-brown above, aeruginous-green below; medulla 100–150 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: Junín, Bosques Peña de Santa Bárbara Natural Reserve; 04°49'N, 73°45'W, 2520 m; 11 November 2012, Lücking & Moncada 35312 (UDBC **holotype**; B **isotype**); *ibid.*; 11 November 2012, Moncada et al. 6327 (B, UDBC **paratypes**).

Distribution and ecology: Wet subparamo and subandine cloud forest zone between 2500 and 3000 m; only known from the type locality in Colombia, growing saxicolous in an exposed microsite.

Notes: This species is characterized by its mid-sized thallus forming numerous, imbricate lobes with undulate, pilose margins. In colour and ecology, *Cora leslactuca* is similar to *C. elephas* (see above), but is overall smaller and thinner, with comparatively thinner margins, and forms more numerous lobes per thallus, reminiscent of a lettuce leaf. Both species are loosely related, but a closer relative of *C. leslactuca* is *C. dewisanti* (see above; Lücking et al. 2014b).

***Cora maxima* Wilk, Dal Forno & Lücking spec. nov.**

Index Fungorum: 552422; *Faces Of Fungi*: 02577; Fig. 8E–G

Etymology: The epithet refers to the rather large size of this species.

Holotype: Wilk 2780a (KRAM).

ITS barcoding sequence: KJ802420 (holotype).

Diagnosis: A rather large, epiphytic *Cora* with olive-green lobes when fresh, with concentric bands of short surface hairs.

Thallus epiphytic on tree trunks and branches, between bryophytes, foliose, up to 20 cm across, composed of 3–5 semicircular, subimbricate lobes; individual lobes 5–10 cm wide and 4–7 cm long, sparsely to moderately branched, with short, radial branching sutures, surface olive-green when fresh, with slight concentric colour zonation, with thick, involute, grey margins, becoming grey in the herbarium. Upper surface more or less even to very shallowly undulate when fresh, undulate-rugose when dry, with concentric bands of short hairs; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), green-grey when fresh, becoming yellowish grey in the herbarium. Thallus in section 300–400 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae supported by a 30–70 µm high ‘medullary’ layer of spaced groups of irregularly arranged to anticlinal, 4–6 µm thick hyphae, upper layer with emerging setae of agglutinated hyphae, setae 200–300 µm long and 20–30 µm thick at the base; photobiont layer 100–150 µm thick; medulla 100–150 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore corticioid, developed as irregular to elongate, resupinate patches partly anastomosing, patches 1–3 mm long and 1–7 mm broad, with cream-coloured to light orange-brown, smooth surface and involute, somewhat fuzzy margins with larger tufts of agglutinate hairs; hymenophore in section 80–120 µm thick, supported by a thickened medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 5–7 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: BOLIVIA. Santa Cruz: Siberia region near La Palma; 17°49'N, 64°40'W, 2580 m; 12 December 2004, Wilk 2780a (KRAM **holotype**; B, LPB **isotypes**).

Distribution and ecology: Known only from Bolivia; a tropical montane rain forest species growing epiphytically on tree trunks and branches.

Notes: This material was previously included in a broad concept of *Cora arachnoidea* (Lücking et al. 2013a), but the molecular data now available, together with the unique morphology, show that it is a distinct taxon. *Cora maxima* shares with *C. arachnoidea* the epiphytic growth habit, rather large thallus, and pilose upper surface, but *C. arachnoidea* s.str. differs in the thallus consisting of numerous, imbricate, comparatively thinner, light green-grey lobes with arachnoid surface. Most other epiphytic species of *Cora* are much smaller, such as *C. smaragdina* from Costa Rica (see below), or have a glabrous surface, such as *C. hymenocarpa* from Costa Rica (see above), which also differs in the light aeruginous-grey, much branched lobes with long, distinct sutures, and the adnate-confluent hymenophore.

***Cora minutula* Lücking, Moncada & Yáñez-Ayabaca spec. nov.**

Index Fungorum: 552423; *Faces Of Fungi*: 02578; Fig. 8H–J

Etymology: The epithet refers to the very small size of this species, being easily overlooked in the field. It also pays homage to the fact that David likes to work with small fungi, in particular lichenicolous species, where he has amassed a large number of publications (e.g., Hawksworth 1977, 1979, 1981, 1994, 2003, 2004; Crittenden et al. 1995; Cole and Hawksworth 2001; Sikaroodi et al. 2001; Hawksworth and Cole 2003) and underlined their importance in the assessment of the evolution of lichenization (Hawksworth 1982).

Holotype: Lücking s.n. (QCNE).

ITS barcoding sequence: KJ780381 (holotype).

Diagnosis: A small, epiphytic *Cora* with irregular, olive lobules forming soredia along the margins and occasionally on the upper and lower side.

Thallus epiphytic on twigs of shrubs, macrosquamulose, up to 2 cm across, composed of 1–5 irregularly shaped, adjacent to dispersed lobes; individual lobes 0.5–1 cm wide and long, unbranched to sparsely branched, without radial branching sutures, surface olive-green to olive-brown when fresh, without concentric colour zonation, with thick, involute, cream-coloured margins, becoming mottled dark and light grey in the herbarium. Upper surface uneven-granular when fresh, rugose when dry, glabrous, sometimes with scattered soredia; involute margins thinly pilose and becoming granular-sorediate in parts; lower surface

ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light grey in the herbarium, sometimes with scattered soredia especially towards the margin. Thallus in section 200–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex collapsed-compacted, formed by a 30–50 µm thick layer of loosely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae; photobiont layer 150–200 µm thick, orange-brown above, aeruginous-green below; medulla 30–70 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: ECUADOR. Napo: Papallacta, paramo of La Virgen; 00°23'N, 78°09'W, 3300 m; 4 July 2010, Lücking 32305 (QCNE **holotype**; B **isotype**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes, thus far only known from the type locality near Quito in Ecuador, growing epiphytically on paramo shrubs.

Notes: Due to its somewhat irregular lobes, this species at first resembles an *Erioderma* rather than a *Cora*. In the dry stage, it is most similar to *C. minor* and other small, sorediate, epiphytic species in that clade, but is phylogenetically unrelated, falling in a clade close to *C. canari* (see above). The irregular, dark olive lobes with uneven surface and the occasional formation of soredia on the underside distinguish *C. minutula* from other small, epiphytic, sorediate taxa.

***Cora palaeotropica* Weerakoon, Aptroot & Lücking spec. nov.**

Index Fungorum: 552424; **Faces Of Fungi:** 02579; Fig. 8K, L

Etymology: The epithet refers to the fact that this is so far the only species known from the Palaeotropics.

Holotype: Weerakoon & Archchige 147a (PD).

ITS barcoding sequence: KX772742, KX772743 (both holotype).

Diagnosis: A small to medium-sized, terrestrial *Cora* with brown-grey lobules lacking a distinct cortex but instead with short, perpendicular hyphae emerging from the photobiont layer.

Thallus terrestrial over soil or detritus or associated with bryophytes, foliose, up to 5 cm across, composed of 3–7 semicircular, adjacent to subimbricate lobes; individual lobes 0.8–1.5 cm wide and 0.7–1.2 cm long, sparsely branched, without distinct, radial branching sutures, surface dark brown-grey when hydrated, without concentric colour zonation, with distinct, involute, light grey margins, becoming light bluish grey in the herbarium. Upper surface uneven when fresh, rugose when dry, appearing minutely felty on close-up; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish, becoming light grey in the herbarium.

Thallus in section 300–400 µm thick, without upper cortex but with photobiont layer and medulla; upper surface formed by short, perpendicular, unbranched hyphae with rounded ends emerging from the photobiont layer; photobiont layer 150–200 µm thick, olive-brown (upper portion) to olive-green (lower portion); medulla 150–200 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed.

Material examined: SRI LANKA. Southern Province: Sinharaja Forest Reserve, Morning Side Estate; 06°23'N, 80°36'E, 783 m; 18 April 2015, Weerakoon & Archchige 147a (PD **holotype**; F **isotype**).

Distribution and ecology: This is so far the only extant species of *Cora* known from the Palaeotropics and the only known from the eastern Palaeotropics, growing on the ground on detritus or between bryophytes. The only other palaeotropical species of the genus is *C. gyrolophia* Fr. from Mauritius (Lücking et al. 2015), but that historic gathering has not been confirmed by more recent collections. Sinharaja Forest Reserve, where the new taxon was collected, is considered a biodiversity hotspot in Sri Lanka and has been declared a Biosphere Reserve and World Heritage Site; the first discovery of the genus *Cora*, with an anatomically unique species, is therefore quite spectacular and supports the importance of this site for conserving biodiversity in South and Southeast Asia.

Notes: While *Cora palaeotropica* is already remarkable in being the only eastern palaeotropical species so far known in the genus, it also provides a unique anatomical feature in that there is no distinct cortex developed; instead, short, unbranched hyphae with rounded ends emerge from the photobiont layer. All other species of *Cora* (and *Corrella*) develop a more or less distinct and characteristic cortex (Dal Forno et al. 2013). Otherwise, the species is morphologically unremarkable, due to its small size and brownish grey colour, resembling other small, terrestrial taxa such as *C. auricolesia* (see above), *C. bovei*, *C. parabovei*, and *C. squamiformis* (see below). These taxa show a tendency to produce a reduced, compacted cortex of anticlinal hyphae, which nevertheless is more or less distinct.

***Cora palustris* Dal Forno, Chaves & Lücking spec. nov.**

Index Fungorum: 552425; **Faces Of Fungi:** 02580; Fig. 8M

Etymology: The epithet (Latin: *palus* = bog, swamp) refers to the habitat where the new species was discovered.

Holotype: Dal Forno 1702 (CR).

ITS barcoding sequence: KJ780597 (holotype), DQ917656, KJ780613 (paratypes).

Diagnosis: A medium-sized, terrestrial, light green-grey species with narrowly undulate lobe surface and collapsed-compacted cortex.

Thallus terrestrial, growing among bryophytes and grasses, foliose, up to 7 cm across, composed of 4–10 semicircular, adjacent to subimbricate lobes; individual lobes 1–3 cm wide and 1–2.5 cm long, moderately branched and rarely with short, radial branching sutures, surface light green-grey to olive-grey when fresh, with some concentric colour zonation, with distinct, involute, white margins, becoming light grey in the herbarium. Upper surface narrowly but distinctly undulate when fresh, undulate when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white when fresh, becoming light grey in the herbarium. Thallus in section 200–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex collapsed-compacted, formed by a 15–25 µm thick layer of densely packed, periclinal, 2–3 µm thick hyphae supported by a poorly developed 20–40 µm high ‘medullary’ layer of spaced groups of loosely packed, anticlinal, 3–5 µm thick hyphae; photobiont layer 80–110 µm thick, light-green to aeruginous; medulla 45–55 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as confluent, resupinate patches forming adnate, reticulate patches up to 3 mm long and up to 5 mm broad, with pale orange, smooth surface and smooth, slightly involute margins; hymenophore in section 80–100 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COSTA RICA. Cartago: Tapantí National Park, Tres de Junio; 09°40'N, 83°51'W, 2700 m; disturbed upland peat bog with scattered shrubs and *Blechnum*; 21 May 2012, Dal Forno 1702 (CR **holotype**; GMUF **isotype**); *ibid.*, Dal Forno 1734 (CR, GMUF **paratypes**), Lücking 34800 (B, CR **paratypes**). COSTA RICA. Cartago: Cerro de la Muerte, Restaurante La Auxilidora; 09°34'N, 83°43'W, 3085 m; 25 January 1988 Lello 250188 (WTU).

Distribution and ecology: Known the Cerro de la Muerte area in Costa Rica, growing on soil among bryophytes and grasses in transitional vegetation between subandine forest and paramo.

Notes: This species agrees with several other species in substrate ecology and size, but can be distinguished by the combination of rather light, grey-green colour and distinctly and narrowly undulate lobe surface. Most similar are *Cora caucensis* from Colombia (see above) in colour, which differs in the even lobe surface and the viaduct-shaped thallus, whereas *C. dulcis* from Mexico (see above), which agrees in the collapsed-compacted cortex, has more aeruginous lobes, also with an even surface. The Colom-

bian *C. celestino* (see above), while agreeing with *C. palustris* in the distinctly undulate lobes and the cortex structure, differs in its darker, olive-grey to olive-brown colour.

Cora parabovei Dal Forno, Kukwa & Lücking **spec. nov.**

Index Fungorum: 552426; *Faces Of Fungi*: 02581; Fig. 8N, O

Etymology: The epithet refers to the close relationship with *Cora bovei*.

Holotype: Kukwa 9457 (UGDA).

ITS barcoding sequence: KJ780571 (isotype).

Diagnosis: A medium to large sized, terrestrial species, distinguishable by the concentric setae present in the thallus surface and densely pilose in the margins.

Thallus terrestrial, foliose, up to 10 cm across, composed of 5–10 semicircular, adjacent to subimbricate lobes; individual lobes 3–6 cm wide and 2–4 cm long, sparsely branched, with long, setose, radial branching sutures, surface dark olive-green when hydrated, with slight concentric colour zonation, with thin, involute, olive-green to grey-green margins, becoming grey in the herbarium. Upper surface even to shallowly undulate when fresh, rugose when dry, with whitish setae arranged in concentric bands; involute margins pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), light green-grey when wetted, becoming light grey in the herbarium. Thallus in section 330–400 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex collapsed-compacted, formed by a 50–100 µm thick layer of more or less loosely packed, irregularly arranged to periclinal, 3–6 µm thick hyphae, with emerging setae formed by agglutinate hyphae, 150–280 µm high; photobiont layer 100–180 µm thick, orange-brown (upper portion) to aeruginous-green (lower portion); medulla 70–170 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as irregularly reticulate, resupinate patches, up to 5 mm long and up to 2 cm broad, with pale yellow to light brown smooth surface and smooth, involute margins; hymenophore in section 110–140 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: BOLIVIA. La Paz: Nor Yungas Province, Cotapata National Park and Integrated Management Area, along Sillu Tincara pre-Columbian route; 16° 17'S, 67°53'W, 3520 m; transition between Páramo Yungueño and Yungas montane cloud forest, on the ground; 25 May 2011, Kukwa 9457 (UGDA **holotype**; LPB, GMUF **isotypes**).

Distribution and ecology: Known only from the type specimen in a transition zone between paramo and montane cloud forest in Bolivia.

Notes: Although phylogenetically close to *Cora bovei* from Chile, *C. parabovei* is morphologically and ecologically very different, as *C. bovei* is a comparatively small, grey-brown, glabrous taxon from Tierra del Fuego. *Cora parabovei* has a rather unique pattern of dense hairs formed in concentric zones. This is one of three species described here that concentrically arranged surface hairs, aside from *C. maxima*, also from Bolivia and *C. dewisanti*, from Venezuela, Ecuador and Colombia (see above). The latter presents a corticioid-cyphelloid hymenophore, while *C. maxima* has glabrous lobe margins and is much larger.

***Cora paraciferrii* Lücking, Moncada & J.E. Hern. spec. nov.**

Index Fungorum: 552427; *Faces Of Fungi*: 02582; Fig. 9A–C

Etymology: The epithet refers to the sister group relationship with what has been named so far *Cora ciferrii* (see below). Raffaele Ciferri was an Italian mycologist who unsuccessfully attempted to introduce a dual nomenclature for lichens (as a symbiotic unit) and the corresponding lichen fungi, by adding the suffix -myces to the existing name, such as *Coraemyces pavoniae* as the fungus involved in the lichen *Cora pavonia*. This topic is at the heart of David Hawksworth's work and was treated in several papers (Hawksworth 1997, 2006; Lücking and Hawksworth 2007).

Holotype: Lücking & Moncada 34005 (ANDES).

ITS barcoding sequences: KJ780428 (holotype), KJ780402, KJ780421, KJ780423, KJ780431, KJ780458, KJ780459, KJ780460, KJ780472, KJ780488, KJ780493, KJ780574 (paratypes).

Diagnosis: A large, terrestrial *Cora* growing between mosses on the ground in wet paramos, with large, ascending, concentrically undulate lobes being light olive-brown when fresh.

Thallus terrestrial, growing between mosses, foliose, up to 30 cm across, composed of 10–20 semicircular, ascending, subimbricate lobes; individual lobes 3–7 cm wide and 3–5 cm long, moderately branched and with short, radial branching sutures, surface light olive-brown when fresh, without or with slight concentric colour zonation, with distinct, involute, cream-coloured to light brown margins, becoming white–grey in the herbarium. Upper surface concentrically undulate when fresh, even to undulate when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), cream-coloured when fresh, becoming yellowish grey in the herbarium. Thallus in section 250–350 µm thick, with upper cortex, photobiont layer, and

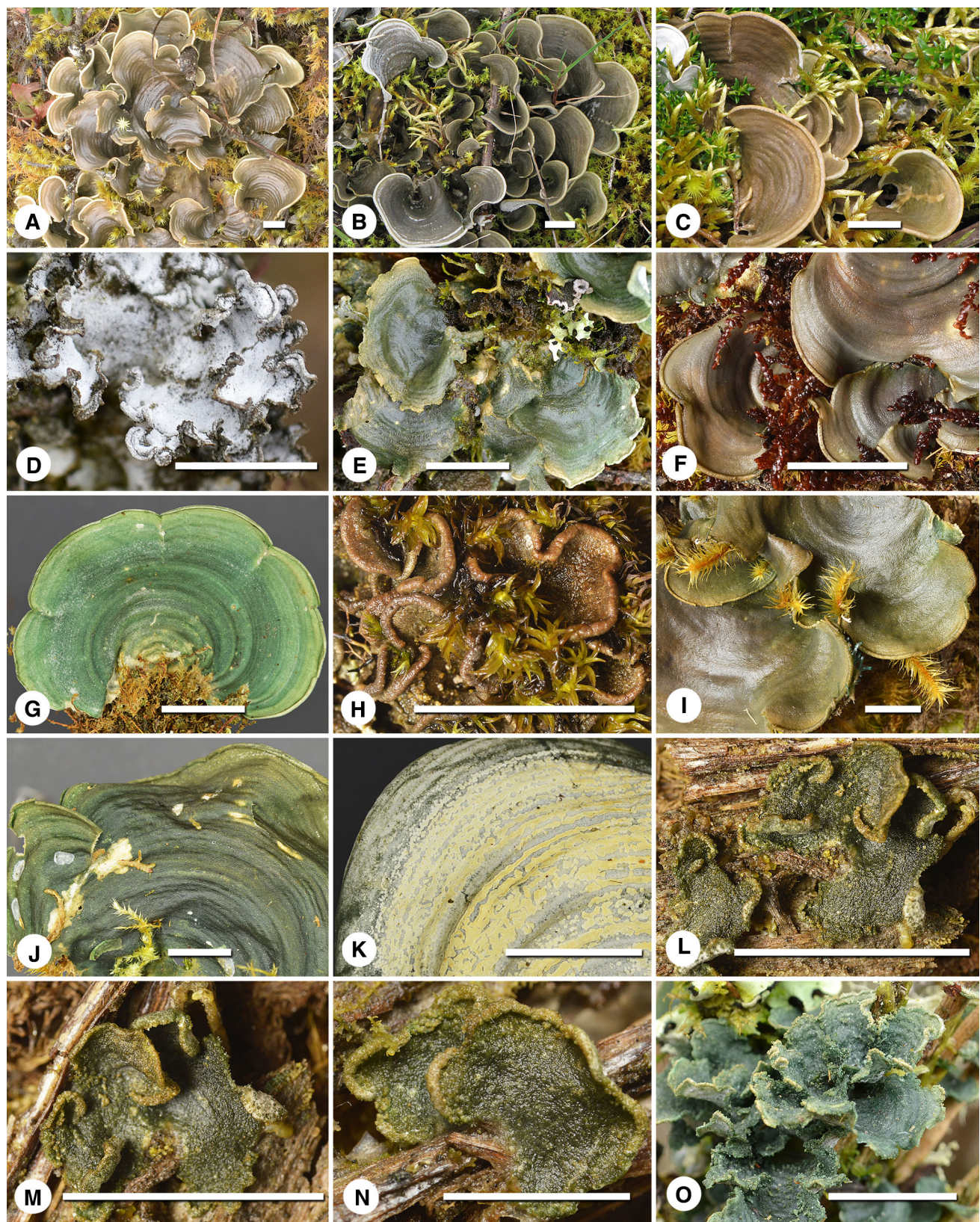
Fig. 9 A–C *Cora paraciferrii* (A holotype; B Lücking 33303; C Lücking 32719). D *C. paraminor* (holotype). E *C. pastorum* (holotype). F *C. pichinchensis* (isotype, rewetted). G *C. pikynasa* (isotype, rewetted). H *C. pseudobovei* (isotype, rewetted). I *C. pseudocorani* (isotype, rewetted). J, K *C. putumayensis* (isotype, in J rewetted, in K underside with hymenophore). L–N *C. quillacinga* (isotype, rewetted). O *C. rothesiorum* (holotype). Scale = 10 mm, in N = 5 mm

medulla; upper cortex diffusely viaduct-shaped, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae supported by a 30–70 µm high ‘medullary’ layer of spaced groups of irregularly arranged to anticlinal, 4–6 µm thick hyphae; photobiont layer 100–150 µm thick, orange-brown above, aeruginous-green below; medulla 50–100 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as rounded to elongate, resupinate patches forming concentric lines, patches 0.3–1 mm long and 0.5–5 mm broad, with cream-coloured, smooth surface and minutely pilose, slightly involute margins; hymenophore in section 50–70 µm thick, supported by a thick medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 5–7 µm; basidia (few observed) 25–35 × 5–7 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: La Calera, paramo of Chingaza; 04°44'N, 73°52'W, 3600 m; 7 November 2011, Lücking & Moncada 34005 (ANDES **holotype**; B, F **isotypes**), 34009 (B, UDBC **paratypes**). Cundinamarca, Choachí, Matarredonda Ecological Park, El Verjón; 04°33'N, 74°00'W, 3220 m; 23 January 2011, Moncada 4596, 4597, 4598 (B, UDBC **paratypes**). Guasca, paramo of Guasca; 04°51'N, 73°49'W, 3220 m; 18 August 2011, Lücking & Moncada 33303, 33388 (B, UDBC **paratypes**). Distrito Capital: Bogotá, paramo of Sumapaz; 04°17'N, 74°13'W, 3700 m; 15 August 2010, Lücking & Moncada 32719, 32721 (B, F, UDBC **paratypes**). Villa Pinzón, paramo of Guacheneque; 05°13'N, 73°32'W, 3335 m; 12 May 2012, Moncada & Suárez 5422 (B, UDBC **paratypes**). VENEZUELA. Mérida: Sierra Nevada, Laguna Negra; 08°48'N, 70°49'W, 3500–3600 m; 7 April 1975, Hale & López-Figueiras 44528 (US). Mérida: Sierra Nevada National Park; 08°47'N, 70°49'W, 3630 m; 6 December 2009, Hernández 1778 (VEN **paratype**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes (Colombia and Venezuela), growing on the ground between bryophytes in semi-exposed to exposed situations.

Notes: *Cora paraciferrii* is closely related to what has been named so far *C. ciferrii*; both were first considered to represent *C. pavonia* (with *Wainiocora ciferrii* as synonym; Lücking et al. 2013a), but the molecular data indicate that



at least two separate, allopatric species are involved and that none of them is *C. pavonia*, the type of the latter being from Jamaica (Lücking et al. 2014c). *Cora ciferrii* has been described from Panama and hence we are applying this name to the clade known from (mostly southern) Colombia and Ecuador, which would be consistent with a Chocó distribution, whereas *C. paraciferrii* is known from central Colombia and Venezuela. It is, however, possible that the Panamanian material represents its own species, considering the ecogeographical isolation north and south of the Darien lowland rain forest, so molecular data from the type location are needed to clarify this.

***Cora paraminor* Dal Forno, Chaves & Lücking spec. nov.**

Index Fungorum: 552428; *Faces Of Fungi*: 02583; Fig. 9D

Etymology: The epithet refers to the close relationship with *Cora minor*.

Holotype: Dal Forno 1718 (CR).

ITS barcoding sequence: KJ780610 (holotype), KJ780608, KJ780609, KJ780611 (paratypes).

Diagnosis: A very small, white–grey, epiphytic species with much branched, curly lobes forming dark olive soredia.

Thallus epiphytic, foliose, up to 3 cm across, composed of 1–4 semicircular, adjacent lobes; individual lobes 0.2–0.7 cm wide and 0.2–0.5 cm long, sparsely to moderately branched (especially towards the tips), without radial branching sutures, surface white–grey when fresh (dark olive-green when wet), becoming white–grey in the herbarium, without concentric colour zonation, with distinct, curly, involute to straight, grey to dark olive-grey margins, remaining a similar colour in the herbarium. Upper surface even when fresh and dry, arachnoid; margins glabrous but with conspicuous, dark olive soredia; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), light grey when fresh, remaining the same colour in the herbarium. Thallus in section 250–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex compacted, formed by a 35–55 µm thick layer of densely packed, periclinal, 2–3 µm thick hyphae; photobiont layer 120–220 µm thick, olive-green to aeruginous-green; medulla 30–60 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed.

Material examined: COSTA RICA. San José: Los Santos Forest Reserve, Cerro de la Muerte; 09°34'N, 83°45'W, 3400–3500 m; 21 May 2012, M. Dal Forno 1718 (CR **holotype**; GMUF **isotype**); *ibid.*, Dal Forno 1716, 1717, 1719 (CR, GMUF **paratypes**).

Distribution and ecology: Known only from the type locality at Cerro de la Muerte in Costa Rica, growing epiphytically on tree branches and twigs in a montane forest.

Notes: *Cora paraminor* is closely related to *C. minor* (Lücking, E. Navarro & Sipman) Lücking, also from Costa Rica (Chaves et al. 2004; Lücking et al. 2013a). Although morphologically and ecologically similar, *C. minor* is from a different locality in Costa Rica, Chirripo National Park, and phylogenetically distinct (Lücking et al. 2014b), suggesting that the two isolated, highest peaks in Costa Rica foster allopatric speciation through microgeographic isolation. Notably, this phenomenon was not observed in *C. terrestris* (see below), which is also known from both localities, indicating that this taxon has been dispersed between the two areas more recently or maintains a larger, less disjunct population. *Cora paraminor* also resembles two other sorediate, sympatric species: *C. hawksworthiana* (see above) and *C. soledavidia* (see below). Both can be differentiated by their yellowish green colouration in the field and their larger lobes, as well as by their habitat: *C. paraminor* grows epiphytically on trees of paramo vegetation, while the other two taxa inhabit subandine forest.

***Cora pastorum* Moncada, Patiño & Lücking spec. nov.**

Index Fungorum: 552429; *Faces Of Fungi*: 02584; Fig. 9E

Etymology: Named after the department in southern Colombia where the species was found.

Holotype: Moncada & Lücking 7878 (UDBC).

ITS barcoding sequence: KX772660 (holotype), KX772689 (paratype).

Diagnosis: A mid-sized, epiphytic species with olive-green thallus when fresh and rather ragged, lighter olive lobe margins, partially furnished with thin surface trichomes.

Thallus epiphytic over bryophytes on paramo shrubs, more or less close to the ground, foliose, up to 3 cm across, composed of 3–5 semicircular, adjacent to subimbricate lobes; individual lobes 1–2 cm wide and 1–2 cm long, adnate to ascending, moderately to frequently branched, especially towards the margins which appear somewhat irregularly ragged to incised, without distinct, radial branching sutures, surface olive-green (to somewhat aeruginous) when fresh, without concentric colour zonation but lighter olive towards the margins, with thin, involute, light yellowish-olive margins, becoming rather dark grey in the herbarium. Upper surface very shallowly undulate when fresh, undulate when dry, thinly pilose especially towards the margins; involute margins shortly and irregularly pilose in parts; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light grey in the herbarium. Thallus in section 200–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffuse-collapsed, formed by a 30–70 µm thick layer of loosely packed, irregularly arranged, 4–6 µm thick hyphae, with emerging setae

formed by tufts of agglutinate hyphae, setae 100–150 µm long and 15–20 µm broad at the base; photobiont layer 150–200 µm thick, olive (upper portion) to bright aeruginous (lower portion); medulla 20–30 µm thick; clamp connections absent but lower medullary hyphae with numerous papilliform, short, basally branched hyphae 3–4 µm thick. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Nariño: Puerres, paramo of Cerro Negro; 00°52'N, 77°24'W, 3423 m; 26 October 2013, Moncada & Lücking 7878 (UDBC **holotype**; B **isotype**); *ibid.*, Moncada & Lücking 7880 (B, UDBC **paratypes**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes, thus far only known from the type locality near Pasto in southern Colombia, growing epiphytically on paramo shrubs.

Notes: This new taxon is distinguished from most other epiphytic, mid-sized species in the olive colour and rather irregular lobe margins. It somewhat resembles the sorediate species *C. davidia* and *C. hawksworthiana* (see above) in the colour of the fresh thalli, but lacks the ample soredia produced by those two species and also has a collapsed, rather than viaduct-shaped, cortex. *Cora pastorum* belongs in the *C. minor* clade (Fig. 2; Online Supplement D), in which most species form small, sorediate thalli.

Cora pichinchensis Paredes, Jonitz & Dal Forno **spec. nov.**

Index Fungorum: 552430; **Faces Of Fungi:** 02585; Fig. 9F

Etymology: Named after the province of the type locality.

Holotype: Paredes 62 (QCNE).

ITS barcoding sequence: KJ780391 (holotype), KJ780553 (paratype).

Diagnosis: A small to mid-sized, terrestrial *Cora*, with rather flat, dark olive-brown lobes when fresh which are adnate to the substrate.

Thallus terrestrial, flattened and associated with bryophytes, foliose, up to 5 cm across, composed of 2–5 semicircular, adjacent to subimbricate lobes; individual lobes 1–2 cm wide and 0.7–1.5 cm long, sparsely branched, without distinct branching sutures, surface dark olive-brown when fresh, without concentric colour zonation, with thin but distinct, involute, light brown margins, becoming white in the herbarium. Upper surface very shallowly undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), cream-coloured when fresh, becoming grey in the herbarium. Thallus in section 250–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex

plectenchymatous, formed by a 80–100 µm thick layer of densely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae; photobiont layer 80–130 µm thick, orange-brown above, aeruginous-green below; medulla 30–70 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: ECUADOR. Pichincha: Pululahua Geobotanical Reserve; 04°40'N, 78°33'W, 1950 m; April 2002, Paredes 62 (QCNE **holotype**; B, F **isotypes**). Pululahua; 00°04'N, 78°30'W, 2295 m; 20 October 2009, Jonitz et al. 436 (B, QCNE **paratypes**).

Distribution and ecology: Known from the Ecuadorian Andes, growing terrestrial associated with bryophytes, rather close and adnate to the ground in shaded to semi-exposed microsites.

Notes: *Cora pichinchensis* is somewhat intermediate morphologically and in its substrate ecology between large, terrestrial species, such as *C. ciferrii*, which develop mostly between large, ground-dwelling mosses, and small, macrosquamulose taxa such as *C. squamiformis*, which grow directly on soil. The colour contrast between the fresh, dark olive-brown and the dry, white thallus is remarkable, caused by the air spaces in the upper cortex that reflect the light when dry.

Cora pikynasa J.-M. Torres, Moncada & Lücking **spec. nov.**

Index Fungorum: 552431; **Faces Of Fungi:** 02586; Fig. 9G

Etymology: The epithet refers to the indigenous word *pi'ky nasa* of the Nasa people, the original inhabitants of the area now covered by the departments of Cauca and parts of Tolima and other departments in Colombia. The word *pi'ky nasa* means community work, specifically community members helping a family in a particular task. The Nasa people in this case helped with access to the collection site.

Holotype: Torres 66 (UDBC).

ITS barcoding sequence: KX772511 (holotype).

Diagnosis: A rather large, epiphytic, grey-green *Cora* similar to *C. suturifera* but less branched with shorter branching sutures and with a collapsed-compacted cortex.

Thallus epiphytic, growing over bryophytes on trees, foliose, up to 10 cm across, composed of 1–5 semicircular, adjacent to subimbricate lobes; individual lobes 3–5 cm wide and 2–3 cm long, moderately branched and with short but distinct, radial branching sutures, surface grey-green when fresh, without distinct concentric colour zonation, with thin, involute, light green-grey margins, becoming grey in the herbarium. Upper surface even to shallowly undulate when fresh, shallowly undulate when dry, glabrous; involute margins glabrous or becoming distinctly setose close to the sutures; lower surface ecorticate, felty-

arachnoid (representing the exposed medulla), light green-grey when fresh, becoming grey in the herbarium. Thallus in section 170–230 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex collapsed-compacted, formed by a 50–70 µm thick layer of loosely to densely packed, irregularly arranged to perpendicular, 4–6 µm thick hyphae; photobiont layer 60–80 µm thick, aeruginous; medulla 50–70 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Tolima: Río Blanco, Vereda Territorios Nacionales; 03°18'N, 75°57'W, 3212 m; 17 January 2014, Torres 66 (UDBC **holotype**; B **isotype**).

Distribution and ecology: Only known from the type location, growing epiphytically on shrubs in the paramo.

Notes: *Cora pikynasa* is one of several large, epiphytic species with rather light, grey-green color when fresh. *Cora arachnoidea* from Venezuela and Colombia (Lücking et al. 2013a) and *C. barbulata* from Costa Rica (Ariyawansa et al. 2015) differ in their arachnoid-pilose lobe surface. *Cora yukiboa* from Puerto Rico (see below) has a distinct bluish tinge and produces medullary papillae. The Ecuadorian *C. cyphellifera* (Lücking et al. 2013a) forms a cyphelloid hymenophore, and *C. hymenocarpa* from Costa Rica (see above) also differs in hymenophore morphology and in the presence of medullary papillae.

***Cora pseudobovei* Wilk, Dal Forno & Lücking spec. nov.**

Index Fungorum: 552432; **Faces Of Fungi:** 02587; **Fig. 9H**

Etymology: The epithet refers to the similarity with *Cora bovei*.

Holotype: Wilk 7562 (KRAM).

ITS barcoding sequence: KJ780372 (holotype).

Diagnosis: A small, terricolous *Cora* growing directly on soil close to the ground, with macrosquamulose thallus and brown, rugose lobes when fresh, and with thick, brown margins.

Thallus terricolous, growing directly on soil, macrosquamulose, up to 2 cm across, composed of 10–20 semicircular, ascendant, adjacent to subimbricate lobes; individual lobes 0.3–0.5 cm wide and 0.3–0.7 cm long, moderately branched, without radial branching sutures, surface brown when fresh, without concentric colour zonation, with thick, involute, brown margins, becoming grey with whitish margins in the herbarium. Upper surface rugose when fresh and dry, glabrous; involute margins smooth to somewhat granular; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), grey-brown when fresh, becoming grey in the herbarium. Thallus in section 200–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex collapsed-compacted, formed by a 20–40 µm thick layer of loosely

packed, irregularly arranged, 4–6 µm thick hyphae, separated from the photobiont layer by a layer of brownish hyphae; photobiont layer 80–100 µm thick, orange-brown above, aeruginous-green below, separated from the medulla by a thick, compacted layer of brownish hyphae; medulla 20–50 µm thick, often indistinct; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: BOLIVIA. La Paz: Franz Tamayo, Madidi National Park, Sanchez Pass between Pelechuco and Kearsa; 14°43'S, 69°08'W, 4677 m; 13 October 2007, Wilk 7562 (KRAM **holotype**; B, F, LPB **isotypes**).

Distribution and ecology: The species is only known from the type collection in high altitude puna in Bolivia, growing on the ground between mosses, well over 4500 m altitude.

Notes: *Cora pseudobovei* is morphologically and ecology similar to *C. squamiformis*, *C. bovei* (Lücking et al. 2013a), and *C. terricoleslia* (see below). The four species found in two entirely unrelated clades, another striking example of parallelism in this genus. *Cora pseudobovei*, which was found in the same area as *C. squamiformis*, is most similar to the unrelated *C. terricoleslia* in gross morphology, differing in some anatomical details, such as the less compacted cortex and the uniformly aeruginous green photobiont layer which is bordered both above and below by a layer of brown hyphae. The closely related *C. bovei*, on the other hand, forms larger lobes with concentrically undulate surface (Lücking et al. 2013a).

***Cora pseudocorani* Lücking, E. Morales & Dal Forno spec. nov.**

Index Fungorum: 552433; **Faces Of Fungi:** 02588; **Fig. 9I**

Etymology: The epithet relates to the fact that this is another terrestrial species somewhat similar to *Cora corani*, found at the same locality.

Holotype: Lücking 29364 (HCUCB-453).

ITS barcoding sequences: KJ780368, KJ802417 (holotype; KJ802417 from 454 pyrosequencing).

Diagnosis: A comparatively large, terrestrial *Cora* with dark olive-green to olive-grey lobes when fresh and almost even surface.

Thallus terrestrial over and between bryophytes, foliose, up to 20 cm across, composed of 5–10 semicircular, subimbricate lobes; individual lobes 3–5 cm wide and 2–4 cm long, sparsely branched and with short, indistinct, radial branching sutures, surface dark olive-green to olive-grey when fresh, without concentric colour zonation but marginal portion rapidly becoming light grey upon drying, with thin but distinct, involute, light olive margins, becoming mottled dark and light grey with grey margins in the herbarium. Upper surface more or less even when fresh,

rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white–grey when fresh, becoming grey in the herbarium. Thallus in section 400–500 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex distinctly viaduct-shaped, formed by a 30–50 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae supported by a 70–150 µm high ‘medullary’ layer of spaced groups of anticlinal, 4–6 µm thick hyphae; photobiont layer 150–200 µm thick, orange-brown above, olive-green below; medulla 50–70 µm thick; clamp connections absent but lower medullary hyphae with papilliform, branched to coralloid hyphae 4–5 µm thick. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: BOLIVIA. Cochabamba: Chapare, Corani Reservoir; 17°16'S, 65°54'W, 3260 m; 7 July 2009, Lücking 29364 (HCUCB-453 **holotype**; F **isotype**).

Distribution and ecology: Only known from the type locality growing terricolous over bryophytes.

Notes: *Cora pseudocorani* was found at the same locality as *C. corani* and the two species are phylogenetically related, with *C. pseudocorani* being sister to the Colombian *C. setosa* (Vargas et al. 2014) and *C. corani* sister to that clade (Lücking et al. 2014b). *Cora pseudocorani* differs from *C. corani* in the darker lobes with more or less even surface and the much lesser degree of branching. The species was included in broad concept of *C. aspera* (Lücking et al. 2013a), but forms a separate clade, also differing in its substrate ecology (Lücking et al. 2014b).

***Cora putumayensis* L.J. Arias, Moncada & Lücking spec. nov.**

Index Fungorum: 552434; **Faces Of Fungi:** 02589; Fig. 9J, K

Etymology: The epithet refers to the famous department of Putumayo, where the type locality is situated.

Holotype: Arias 2422 (UDBC).

ITS barcoding sequence: KX772611 (holotype), KX772608 (paratype).

Diagnosis: A large to very large, epiphytic *Cora* with dark olive-green lobes, concentrically reticulate hymenophore, and wart-shaped papillae in the lower medulla.

Thallus epiphytic, growing on trees and branches, foliose, up to 15 cm across, composed of 3–7 semicircular lobes per thallus, ascending; lobes 3–8 cm wide and 3–5 cm long, sparsely to moderately branched, with short to indistinct, radial branching sutures, dark olive-green when hydrated, with thin but distinct, involute, light olive-green margins, becoming grey in the herbarium. Upper surface even to shallowly and narrowly undulate when fresh, undulate when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the

exposed medulla), cream-coloured when fresh, becoming grey in the herbarium. Thallus in section 250–330 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex very diffusely viaduct-shaped, formed by a 20–30 µm thick layer of rather loosely woven, irregularly arranged, 3–5 µm thick hyphae supported by a 50–100 µm high ‘medullary’ layer of irregularly arranged to anticlinal, 3–5 µm thick hyphae; photobiont layer 50–100 µm thick, olive-green (upper portion) to aeruginous-green (lower portion); medulla 70–100 µm thick; clamp connections absent, but lower medullary hyphae with numerous papilliform to wart-shaped, unbranched to branched hyphae 3–5 µm thick. Hymenophore developed as resupinate, linear to reticulate patches dispersed on the underside, patches 0.5–1 mm long and 10–50 mm broad, with pale yellow, smooth surface and slightly involute, minutely felty margins; hymenophore in section 80–100 µm thick, composed of a paraplectenchymatous layer resting on loose, 4–6 µm thick, medullary hyphae and supporting the hymenium; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–5 µm; basidia 20–35 × 5–7 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Putumayo: San Francisco, km 7.5 on road Mocoa-San Francisco; 01°11'N, 76°50'W, 2474 m; 15 May 2014, Arias 2422 (UDBC **holotype**; B, HUQ **isotypes**); ibid., Arias 241 (B, HUQ, UDBC **paratypes**).

Distribution and ecology: Known only from the type locality, growing epiphytically on trees and branches in a montane rain forest.

Notes: *Cora putumayensis* is in many aspects (ecology, color, size, anatomy) similar to the Bolivian *C. maxima* (see above). However, the latter differs in the concentrically setose lobe surface and the absence of medullary papillae. The epiphytic *C. arborescens* (see above) and *C. suturifera* (see below) can develop large lobes up to 5 cm broad, but are lighter emerald-green when fresh; *C. suturifera* also differs in the long branching sutures, the plectenchymatous cortex, and the absence of medullary papillae.

***Cora quillacinga* Moncada, F. Ortega & Lücking spec. nov.**

Index Fungorum: 552435; **Faces Of Fungi:** 02590; Fig. 9L–N

Etymology: The epithet, as a noun in apposition, refers to the Quillacinga people, original indigenous inhabitants of the department of Nariño (López 2000).

Holotype: Moncada & Lücking 7906 (UDBC).

ITS barcoding sequence: KX772701 (holotype).

Diagnosis: A very small, terrestrial *Cora* with irregular, olive lobules forming scattered soredia along the margins and occasionally on the upper and lower side.

Thallus terrestrial on dead plant material, macrosquamulose, up to 1 cm across, composed of 1–5 semicircular to irregularly shaped, adnate, adjacent to dispersed lobes; individual lobes 0.3–0.5 cm wide and long, unbranched, without radial branching sutures, surface olive-green when fresh, without concentric colour zonation, with distinct, involute, light olive margins, becoming dark grey in the herbarium. Upper surface uneven-granular when fresh, rugose when dry, glabrous, sometimes with scattered soredia; involute margins thinly pilose and becoming granular-sorediate in parts; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light grey in the herbarium, sometimes with scattered soredia especially towards the margin. Thallus in section 180–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex compacted, formed by a 20–30 µm thick layer of densely packed, irregularly arranged to periclinal, 4–5 µm thick hyphae; photobiont layer 100–150 µm thick, orange-brown above, aeruginous-green below; medulla 30–70 µm thick, strongly hydrophobic; clamp connections absent but lowermost medullary hyphae with papilliform, branched hyphae 3–4 µm thick. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Nariño: Puerres, paramo of Cerro Negro; 00°51'N, 77°25'W, 3420 m; 26 October 2013, Moncada & Lücking 7906 (UDBC **holotype**; B **isotype**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes, thus far only known from the type locality near Pasto in southern Colombia, growing on dead plant material.

Notes: This species is almost indistinguishable from *Cora minutula* (see above), both being small, macrosquamulose species with irregular, olive-green lobules becoming sorediate and with thinly pilose margins. The only discernible difference is the thicker margins in *C. minutula*. Notably, both species are unrelated and belong to either one of the two large *Cora* clades, which are characterized by associating with two different photobiont species (Dal Forno 2015). This is a further, striking case of parallelism in the genus. Similar cases have been documented for foliose *Lobariaceae* in the genus *Sticta* and for crustose *Graphidaceae* (Rivas Plata and Lumbsch 2011; Moncada et al. 2014a).

***Cora rothesiorum* Moncada, Madriñán & Lücking spec. nov.**

Index Fungorum: 552436; **Faces Of Fungi:** 02591; **Fig. 9O**

Etymology: The epithet refers to the origin of David's second name Leslie, from the lowland Scottish Clan Leslie,

first formed in the 11th century, whose chiefs from the 15th century on also held the position of Earl of Rothes.

Holotype: Lücking & Moncada 34060 (ANDES).

ITS barcoding sequences: KJ780445 (holotype), KJ780444, KJ780490 (paratypes).

Diagnosis: A small, epiphytic *Cora* with fan-shaped lobes of dark, aeruginous to olive-green colour when fresh, and irregular, crisp, sorediate margins.

Thallus epiphytic on twigs of shrubs, foliose, up to 3 cm across, composed of 3–7 semicircular to fan-shaped, adjacent lobes; individual lobes 0.5–1 cm wide and 0.3–0.8 cm long, sparsely branched and with short, radial branching sutures, surface dark aeruginous to olive-green when fresh, without distinct concentric colour zonation, with thin, involute, yellowish to aeruginous margins, becoming grey in the herbarium. Upper surface shallowly undulate when fresh, undulate-rugose when dry, glabrous or rarely with few, scattered, whitish setae; involute margins becoming granulose to sorediate, rather irregular and crisp; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), cream-coloured to aeruginous-white when fresh, becoming pale yellowish grey in the herbarium. Thallus in section 180–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex collapsed-compacted, formed by a 30–50 µm thick layer of loosely packed, irregularly arranged to periclinal, 4–6 µm thick hyphae; photobiont layer 50–150 µm thick, aeruginous; medulla 30–50 µm thick; clamp connections absent but lowermost medullary hyphae with numerous papilliform, short, unbranched hyphae 2–3 µm thick. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: La Calera, paramo of Chingaza; 04°44'N, 73°52'W, 3600 m; 7 November 2011, Lücking & Moncada 34060 (ANDES **holotype**; B, F **isotypes**), 34058 (ANDES, B, F **paratypes**). Cundinamarca: Guasca, paramo of Guasca; 04°51'N, 73°49'W, 3220 m; 18 August 2011, Lücking & Moncada 33347 (B, UDBC **paratypes**). Choachí, Matarrendonda Ecological Park; 04°34'N, 74°00'W, 3484 m; 28 November 2014, Moncada 8887 (B, UDBC **paratypes**).

Distribution and ecology: Wet paramos of the northern Andes close to Bogotá in Colombia, growing epiphytically on twigs of paramo shrubs in more or less shaded microsites.

Notes: *Cora rothesiorum* is distinguished from other small, epiphytic species of the genus by its dark, aeruginous to olive-green colour and irregular, crisp, sorediate margins. It belongs in the *C. minor* clade (Lücking et al. 2014b), where most other species differ by the whitish thallus lobes; most species in this clade do produce soredia.

***Cora rubrosanguinea* Nugra, Moncada & Lücking spec. nov.**

Index Fungorum: 552437; *Faces Of Fungi*: 02592; Fig. 10A–C

Etymology: The epithet refers to the wine-red pigment forming and bleeding out after rewetting of dry herbarium material.

Holotype: Nugra 818 (HA).

ITS barcoding sequence: KJ780400 (holotype), KJ780395 (paratype).

Diagnosis: A large, terrestrial *Cora* with olive-green, even to shallowly undulate lobes with cream-coloured margins when fresh, forming a wine-red pigment that bleeds out after rewetting of herbarium specimens; hymenophore stereoid-cyphelloid, very large and prominent.

Thallus terrestrial or saxicolous between mosses, foliose, up to 15 cm across, composed of 1–5 semicircular, adjacent to subimbricate lobes; individual lobes 3–5 cm wide and 3–5 cm long, sparsely to moderately branched, with indistinct, radial branching sutures, surface olive-green when fresh, with slight concentric colour zonation, with thick, involute, cream-coloured margins, becoming grey in the herbarium but upon rewetting forming a wine-red pigment that partially bleeds out, surface then remaining with a reddish tinge and margins red-brown. Upper surface even to shallowly undulate when fresh, undulate-rugose when dry, glabrous; involute margins densely pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), cream-coloured when fresh, becoming grey in the herbarium. Thallus in section 450–550 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex distinctly viaduct-shaped, formed by a 20–30 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae supported by a 100–150 µm high ‘medullary’ layer of spaced groups of densely packed, anticlinal, 4–6 µm thick hyphae; photobiont layer 100–150 µm thick, orange-brown above, aeruginous-green below, associated fungal hyphae orange; medulla 150–250 µm thick, with numerous setae of agglutinated hyphae; clamp connections absent, papilliform hyphae absent. Hymenophore developed as single, large, stereoid-cyphelloid structure, patches 5–10 mm long and 5–20 mm broad, with cream-coloured, smooth surface and rugose, involute margins; hymenophore in section 100–150 µm thick, supported by a massive medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 25–35 × 5–7 µm; basidia 30–40 × 5–7 µm, 4-sterigmate; basidiospores not observed. Chemistry: Producing copious redbrown pigment upon rewetting.

Material examined: ECUADOR. Cañar: Tambo; 02°26' S, 78°52'W, 3909 m; 4 March 2009, Nugra 818 (HA **holotype**; B **isotype**); *ibid.*, Azuay: Camilo Ponce Enriquez, Concesión Minera IMC; 02°48'S, 79°22'W, 300 m; 12 December 2009, Nugra 866 (B, F, HA **paratypes**).

Distribution and ecology: Known from the northern Andes in Ecuador, growing terrestrially or over rock between bryophytes in semi-exposed situations.

Notes: *Cora rubrosanguinea* is a rather unique species due to the copious pigment forming by rewetting herbarium specimens. This phenomenon has been observed in all other species belonging to this clade (Lücking et al. 2014b), although to a lesser extent, and denotes a distinct synapomorphy.

***Cora santacruzensis* Dal Forno, Bungartz & Yáñez-Ayabaca, spec. nov.**

Index Fungorum: 552438; *Faces Of Fungi*: 02593; Fig. 10D

Etymology: The epithet refers to the locality type, Santa Cruz Island, where the new species was found in the Galapagos.

Holotype: Yáñez-Ayabaca 1547 (CDS).

ITS barcoding sequence: KJ780565 (holotype), KX7724 55 (paratype).

Diagnosis: A mid-sized, green, epiphytic species with coralloid papillae in the lower medulla.

Thallus epiphytic, growing on bryophytes mostly over branches, foliose, up to 5 cm across, composed of 1–3 semicircular lobes per thallus, parallel to the substrate; lobes 1–3 cm wide and 1–3 cm long, sparsely branched, with short radial branching sutures, emerald-green when hydrated, with thin, involute, light yellowish-green margins, becoming yellowish grey in the herbarium. Upper surface even to shallowly undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), cream-coloured when fresh, becoming grey in the herbarium. Thallus in section 200–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 10–25 µm thick layer of rather loosely woven, irregularly arranged, 2–3 µm thick hyphae supported by a 20–30 µm high ‘medullary’ layer of irregularly arranged to anticlinal, 3–5 µm thick hyphae; photobiont layer 90–120 µm thick, aeruginous-green, associated fungal hyphae orange; medulla 50–80 µm thick; clamp connections absent, but lower medullary hyphae with numerous papilliform, branched to coralloid hyphae 3–5 µm thick. Hymenophore developed as resupinate, linear to rarely reticulate patches dispersed on the underside, patches 0.2–0.5 mm long and 1–7 mm broad, with pale yellow, smooth surface and flat, smooth margins; hymenophore in section 70–80 µm thick, composed of a paraplectenchymatous layer resting on loose, 4–6 µm thick, medullary hyphae and supporting the hymenium; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 12–30 × 4–5 µm; basidia 20–35 × 5–7 µm, 4-sterigmate; basidiospores 6–8 × 3–5 µm.



Fig. 10 A–C *Cora rubrosanguinea* (isotype, rewetted, with vine-red pigment appearing, in C underside with hymenophore). D *C. santacruzensis* (isotype, rewetted). E–H *C. schizophylloides* (holotype, in F rewetted, in G, H underside with hymenophore). I, J *C. smaragdina* (isotype, in J underside with hymenophore). K, L *C. soreddavidia* (holotype, in L underside with hymenophore). M *C. subdavicrinia* (isotype). N, O *C. suturifera* (N isotype, rewetted; O field image by B. Besal). Scale = 10 mm, in G, H, and J = 5 mm

Material examined: ECUADOR. Galapagos: Santa Cruz Island, abandoned farm behind El Puntudo; 00°38'S, 90°20' W, 730 m; tall forest of *Persea americana*, *Cinchona pubescens* and *Scalesia pedunculata*, growing over hepatics on branch of *Persea americana* in semi-shaded conditions; 28 October 2010, Yáñez-Ayabaca 1547 (CDS 45041 **holotype**; GMUF **isotype**); *ibid.*, along trail from El Puntudo to abandoned farm of Don Benito; on bark; 8 February 2007, Bungartz 5594 (CDS 33039, GMUF **paratypes**).

Distribution and ecology: *Cora santacruzensis* is one of two presumably endemic species of the genus in Galapagos. It is known from a few specimens of what seems to be a single population on Santa Cruz Island. Both the holotype and the paratype were collected on introduced trees, the holotype on avocado (*Persea americana*), the paratype on quinine (*Chinchona pubescens*). The possibility that this basidiolichen is not endemic can therefore not completely be discarded. Nevertheless, the species takes a rather isolated phylogenetic position (Lücking et al. 2014b) and its habitat is among the last remnants of forests dominated by endemic *Scalesia pedunculata* trees. Today these forests generally cover less than 5 % of their original area. Among these forests, *C. santacruzensis* was found at a site where *Scalesia* trees still reach considerable size (up to 50 cm in diam. and up to 10 m tall). Anywhere else on Santa Cruz, stands of *Scalesia* are composed of much smaller trees. The forest where *C. santacruzensis* grows therefore must be considered one of the last remaining old-growth *Scalesia* forests in the archipelago. Unfortunately this area has in the past been used as farmland and today introduced crops (avocado, manioc or yuca, banana, sugarcane and pineapple) are still common among the ancient *Scalesia* trees.

Notes: *Cora santacruzensis* agrees with three other, medium-sized, green species forming medullary papillae, namely *C. boleslia*, *C. haledana* (see above), and *C. vilie-woa* (see below). It differs from these chiefly by the shallowly undulate lobe surface and from the latter two also in the more or less viaduct-shaped cortex; *C. boleslia* is similar in gross morphology but not closely related (Fig. 2; Online Supplement D).

Cora schizophylloides Moncada, C. Rodríguez & Lücking **spec. nov.**

Index Fungorum: 552439; *Faces Of Fungi*: 02594; Fig. 10E–H

Etymology: The epithet refers to the strong resemblance of the dry thalli with the widespread fungus *Schizophyllum commune*.

Holotype: Moncada 7218 (UDBC).

ITS barcoding sequence: KX772719 (holotype).

Diagnosis: A small, epiphytic *Cora* with much branched, olive-brown to olive-grey lobes mottled with white when fresh but becoming white when dry, with densely arachnoid-pilose surface and large, cyphelloid hymenophore.

Thallus epiphytic on paramo shrubs, foliose, up to 5 cm across, composed of 5–10 semicircular to flabellate, adjacent to subimbricate lobes; individual lobes 0.5–1 cm wide and 0.5–1.5 cm long, ascending, moderately to frequently branched, without distinct, radial branching sutures, surface olive-brown to olive-grey mottled with white when fresh, without concentric colour zonation, with thin, involute, light yellowish grey margins, becoming white in the herbarium with olive-brown submarginal zone. Upper surface uneven when fresh, rugose when dry, densely covered with irregular to projecting setae; involute margins pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light grey in the herbarium. Thallus in section 300–400 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–30 µm thick layer of densely packed, periclinial, 4–6 µm thick hyphae supported by a 100–150 µm high 'medullary' layer of spaced groups of anticlinial, 4–6 µm thick hyphae, upper layer with numerous setae formed by agglutinate hyphae, setae 200–400 µm long and 20–30 µm thick at the base; photobiont layer 100–150 µm thick, orange-brown above, olive-green below; medulla 30–60 µm thick, slightly hydrophobic; clamp connections absent but lowermost medullary hyphae with short, papilliform, globose to branched hyphae 3–4 µm thick. Hymenophore cyphelloid but somewhat adnate, patches 0.5–0.8 cm long and broad, with cream-coloured to yellowish, smooth surface and indistinct margins; hymenophore in section 40–60 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–25 × 4–6 µm; basidia and basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cauca: Inzá, paramo of Guanacas-Las Delicias; 02°30'N, 76°14'W, 3330 m; 16 October 2013, Moncada 7218 (UDBC **holotype**; B **isotype**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes, thus far only known from the type locality in Colombia, growing epiphytically on paramo shrubs.

Notes: When dry, this new species strongly resembles a non-lichenized *Schizophyllum commune*, with the much branched, somewhat convex, whitish, hairy lobes. Its sister species is *Cora hirsuta*, a terrestrial taxon with a similarly dense cover of obliquely upright setae and also a narrow, dark, submarginal zone (Lücking et al. 2013a, 2014b). Both species differ in substrate ecology and colour when fresh, with *C. hirsuta* remaining mostly white with the submarginal band olive-green.

Cora smaragdina Lücking, Rivas Plata & Chaves **spec. nov.**

Index Fungorum: 552440; *Faces Of Fungi*: 02595; Fig. 10I, J

Etymology: Referring to the emerald-green colour of the hydrated lobes.

Holotype: Lücking & Rivas Plata 21016 (B).

ITS barcoding sequence: EU825960 (holotype).

Diagnosis: A mid-sized, epiphytic rain forest *Cora* with adnate, emerald-green lobes when fresh, with scattered trichomes and shallow concentric undulation.

Thallus epiphytic on tree bark, foliose, up to 5 cm across, composed of 2–5 semicircular, adjacent to subimbricate lobes; individual lobes 1–2 cm wide and 0.7–1.5 cm long, sparsely to moderately branched and with short, radial branching sutures, surface emerald-green when fresh, without concentric colour zonation, with thin, involute, aeruginous margins, becoming yellowish grey in the herbarium. Upper surface broadly and shallowly undulate and rugose when fresh, rugose when dry, mostly glabrous but with few, scattered trichomes towards the margins; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light yellowish grey in the herbarium. Thallus in section 200–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–30 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae supported by a 70–120 µm high ‘medullary’ layer of spaced groups of anticlinal, 4–6 µm thick hyphae, upper layer with scattered setae formed by agglutinate hyphae, setae 100–200 µm long and 15–20 µm thick at the base; photobiont layer 50–100 µm thick, olive-green above, aeruginous-green below; medulla 30–50 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as rounded to elongate, resupinate patches forming irregular, concentric lines, patches 0.3–0.5 mm long and 0.3–2 mm broad, with pale yellowish, smooth surface and smooth to rough, involute margins; hymenophore in section 70–100 µm thick, supported by a thickened medullary layer; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–7 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COSTA RICA. Puntarenas: Las Cruces Biological Station; 08°47'N, 82°57'W, 1200 m; 15–16 September 2007, Lücking & Rivas Plata 21016 (B **holotype**).

Distribution and ecology: Known only from southern Costa Rica; a tropical montane rain forest species growing epiphytically on tree bark in shaded to semi-exposed condition.

Notes: *Cora smaragdina* resembles quite a number of other medium-sized, epiphytic species with green lobes when fresh. Most of these differ in their lower, medullary papillae, whereas *C. canari* (see above), *C. suturifera*, *C. udebeceana*, and *C. verjonensis* (see below), agree with *C. smaragdina* in the absence of such papillae, as well as in the mostly undulate lobe surface. Among these, *C. suturifera* from Ecuador is clearly set apart by the conspicuous branching sutures and the plectenchymatous cortex, whereas *C. udebeceana* from Colombia has a rather thin thallus with compacted cortex. The Colombian *C. verjonensis* can be distinguished by the adnate-confluent, spot-shaped hymenophore resembling ascomata of *Myriostigma* species, and *C. canari* from Ecuador by the rather strongly undulate lobe surface. As in other similar cases, none of these taxa are closely related, further emphasizing the substantial degree of parallelism in this genus (Lücking et al. 2014b; Fig. 2; Online Supplement D).

Cora soredavidia Dal Forno, Marcelli & Lücking **spec. nov.**

Index Fungorum: 552441; *Faces Of Fungi*: 02596; Fig. 10K, L

Etymology: The epithet is a combination of a reference to the sorediate margins with the name David.

Holotype: Dal Forno & Marcelli 2019 (CGMS).

ITS barcoding sequence: KJ780601 (holotype), KJ780649, KJ780650 (paratypes).

Diagnosis: A very small, epiphytic *Cora* with light olive-green to yellowish green lobes producing yellowish-brown soredia along the margins.

Thallus epiphytic, growing on bryophytes (e.g., *Frullania*) and decaying matter, foliose, up to 3 cm across, composed of 2–5 semicircular, adjacent lobes; individual lobes 0.6–1.7 cm wide and 0.5–1 cm long, sparsely branched and with very short, radial branching sutures; surface yellowish green to light olive-green when fresh, without concentric colour zonation, becoming grey in the herbarium, with distinct, involute, cream-coloured margins producing scattered, yellowish-brown soredia, becoming grey in the herbarium. Upper surface rugose when fresh and dry, glabrous but with scattered, yellowish brown soredia; margins glabrous; soredia present on the lamina, sutures and along the margins; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), light-green when fresh, becoming light grey in the herbarium.

Thallus in section 250–320 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex viaduct-shaped, formed by a 20–25 µm thick layer of densely packed, irregularly arranged to periclinal, 3–5 µm thick hyphae supported by a 50–100 µm high ‘medullary’ layer of spaced groups of more loosely packed, anticlinal, 3–6 µm thick hyphae; photobiont layer 80–150 µm thick, aeruginous-green; medulla 30–40 µm thick; clamp connections absent but lower medullary hyphae with numerous papilliform, unbranched to branched hyphae 3–4 µm thick. Hymenophore developed as very neatly rounded, flattened-cyphelloid, disc-shaped patches with a central “knob”, up to 1.5 mm diam., confluent, with white, smooth surface and indistinct margins; hymenophore in section 90–100 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: BRAZIL. Minas Gerais: Município de Itamonte, Itatiaia National Park; 22°22'S, 44°44'W, 2270 m; 5 January 2013, Dal Forno & Marcelli 2019 (CGMS **holotype**; GMUF, hb. Marcelli **isotypes**); *ibid.*, Dal Forno & Marcelli 2022 (GMUF, hb. Marcelli **paratypes**). COSTA RICA. Cartago: Tapantí National Park opposite Cerro de la Muerte; 09°34'N, 83°45'W, 3300–3400 m; 21 May 2012, Dal Forno 1709 (CR, GMUF **paratypes**).

Distribution and ecology: Known only from the type locality in Cerro de la Muerte in Costa Rica and from similar vegetation in the southeastern Atlantic rain forest in Brazil, growing epiphytically on tree branches and twigs and on decaying matter.

Notes: *Cora soredavidia* is one few sorediate species in the genus and is only one of two broadly distributed species, both sorediate, the other being *Cora hawksworthiana* (see above). Both agree in gross morphology but the latter is larger in size and forms very conspicuous, broad marginal bands of soredia; also it is darker when wettened and has a differently shaped hymenophore. Phylogenetically, both taxa are unrelated (Lücking et al. 2014b): whereas *C. soredavidia* is found at the base of one of the two large *Cora* clades, *C. hawksworthiana* forms part of a subclade that also contains *C. aspera* and *C. santacruzensis* (see above). Our studies also show that both have different *Rhizonema* (photobiont) species (Dal Forno 2015), and the thallus of *C. soredavidiana* does not show photobiont layers that differ in colour in the upper and lower portion, as in *C. hawksworthiana*.

***Cora subdavicrinita* Moncada, J. Molina & Lücking spec. nov.**

Index Fungorum: 552442; *Faces Of Fungi*: 02597; Fig. 10M

Etymology: The epithet refers to the superficial similarity with *Cora davicrinita*.

Holotype: Lücking & Moncada 34053 (UDBC).

ITS barcoding sequences: KJ780441 (holotype).

Diagnosis: A small, epiphytic *Cora* with thinly arachnoid, white surface compact to subsorediate, cream-coloured to olive-green margins.

Thallus epiphytic on bark of shrubs, macrosquamulose, up to 2 cm across, composed of 2–5 semicircular, adjacent to dispersed lobes; individual lobes 0.3–1 cm wide and 0.2–0.7 cm long, unbranched to sparsely branched and without radial branching sutures, surface olive-green mottled with white when fresh, without concentric colour zonation, with distinct, involute, cream-coloured to olive-green margins, becoming light grey in the herbarium. Upper surface even when fresh, rugose when dry, thinly arachnoid; involute margins compact or partly becoming granulose-sorediate; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white–grey when fresh, becoming grey in the herbarium. Thallus in section 250–300 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex distinctly diaduct-shaped, formed by a 20–30 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae supported by a 80–120 µm high ‘medullary’ layer of spaced groups anticlinal, 4–6 µm thick hyphae, upper layer with scattered, emergent setae formed by agglutinate hyphae, setae 50–150 µm long and 15–25 µm thick at the base; photobiont layer 50–100 µm thick, olive-green above, aeruginous-green below; medulla 30–70 µm thick; clamp connections absent but lowermost medullary hyphae with numerous papilliform, branched hyphae 4–5 µm thick. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: La Calera, paramo of Chingaza; 04°44'N, 73°52'W, 3600 m; 7 November 2011, Lücking & Moncada 34053 (ANDES **holotype**; B, F **isotypes**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes (Colombia, Ecuador), growing epiphytically on paramo shrubs, between bryophytes and other lichens.

Notes: *Cora subdavicrinita* is superficially similar to *C. davicrinita* (see above), but is not related to the latter species and instead belongs in an entirely different clade, where it is positioned close to the much larger, terricolous and saxicolous species *C. dalehana* and *C. davibogotana* (see above; Lücking et al. 2014b). *Cora subdavicrinita* differs from *C. davicrinita* in the more compact lobe surface and margins, becoming only partially sorediate.

***Cora suturifera* Nugra, Besal & Lücking spec. nov.**

Index Fungorum: 552443; *Faces Of Fungi*: 02598; Fig. 10N, O

Etymology: The epithet refers to the very distinct sutures or seams connecting the lobes after branching in this species. Symbolically, this relates to the impact David's work has had in integrating and seaming together lichenology and mycology, both systematically and nomenclaturally.

Holotype: Nugra 862 (HA).

ITS barcoding sequence: KJ780399 (holotype).

Diagnosis: A medium-sized to large, epiphytic *Cora* with emerald-green, concentrically undulate lobes when fresh and very distinct, long, radial branching sutures.

Thallus epiphytic on twigs of trees and shrubs, foliose, up to 15 cm across, composed of 5–15 semicircular, adjacent to subimbricate lobes; individual lobes 2–5 cm wide and 2–5 cm long, moderately to frequently branched and with long, very distinct, radial branching sutures, surface emerald-green when fresh, without distinct concentric colour zonation, with thin, involute, grey-green margins, becoming grey in the herbarium. Upper surface undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous or becoming distinctly setose close to the sutures; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), concentrically green-grey when fresh, becoming grey in the herbarium. Thallus in section 150–200 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex plectenchymatous, formed by a 40–60 µm thick layer of densely packed, irregularly arranged to periclinal, 4–5 µm thick hyphae; photobiont layer 50–100 µm thick, aeruginous; medulla 30–50 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: ECUADOR. Morona Santiago: Taisha, Kutucú Shaime Protected Forest; 03°27'S, 78°40' W, 878 m; 29 August 2009, Nugra 862 (HA **holotype**; B **isotype**).

Distribution and ecology: Known only from the type locality in a submontane rain forest, growing epiphytically on twigs.

Notes: This species is similar to *Cora canari*, *C. haeceweorthensis*, and *C. imi* (see above) in surface colour and general lobe morphology. The latter two are terrestrial species known from Colombia and Costa Rica, whereas *C. canari* is an epiphytic species collected at the same locality as *C. suturifera*. *C. canari* differs in the small thallus lacking distinct sutures; in the field, it could be considered a young specimen of *C. suturifera*, but the two taxa form phylogenetically separate lineages, *C. canari* being related to two endemic species from Galapagos and *C. suturifera* to the Andean *C. aspera* (Lücking et al. 2013a, 2014b). The observation that morphologically very similar species of *Cora* are phylogenetically unrelated and have partially differentiated substrate ecology and geographic ranges parallels what has been found in the *Lobariaceae*,

Fig. 11 A, B *Cora terrestris* (A holotype; B Dal Forno 1711). C *C. terricoleslia* (isotype, rewetted). D *C. squamiformis* (isotype, rewetted). E *C. udebeceana* (isotype, rewetted). F *C. urceolata* (holotype). G, H *C. verjonensis* (isotype, in G rewetted, in H underside with hymenophore). I–L *C. viliewoa* (I isotype, rewetted; J Soto 106, underside with hymenophore; K, L Dal Forno 1921, in K dry lobe on leaf surface, in L underside with hymenophore). M–O *C. yukiboa* (holotype, in N underside with hymenophore, in O section through medulla showing papilliform hyphae). Scale = 10 mm, in D and L = 5 mm, in O = 10 µm (photos in K, L by Tim Wheeler)

particularly the genus *Sticta*, where species corresponding to the morphodem of *S. fuliginosa* and *S. weigelii* have evolved multiple times independently (Moncada et al. 2014a). *Cora suturifera* was also observed in the Maquipucuna Reserve NE of Quito and photographically documented by the second author, although not collected, a notable example of citizen science contributing to cataloguing our planet's biodiversity.

***Cora terrestris* Dal Forno, Chaves & Lücking spec. nov.**

Index Fungorum: 552444; **Faces Of Fungi:** 02599; Fig. 11A, B

Etymology: The name (Latin: *terra* = soil, ground) is a reference to the substrate ecology of this species.

Holotype: Dal Forno 1701 (CR).

ITS barcoding sequence: KJ780596 (holotype), EU825963, KJ780589, KJ780595, KJ780603, KJ780678 (paratypes).

Diagnosis: A medium-sized, terrestrial *Cora* with olive-grey to grey-brown lobes when fresh and a shallowly undulate surface.

Thallus terrestrial, growing among bryophytes, foliose, up to 8 cm across, composed of 5–17 semicircular, adjacent imbricate lobes; individual lobes 1–2.5 cm wide and 0.5–2 cm long, sparsely to moderately branched and with short, radial branching sutures, surface olive grey to grey-brown towards the center and lighter towards the tips when fresh, with slight concentric colour zonation, with distinct, involute, white margins, becoming grey-white with yellowish margins in the herbarium. Upper surface even to shallowly undulate when fresh, rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), white when fresh, becoming grey-white in the herbarium. Thallus in section 170–240 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex upper cortex diffusely viaduct-shaped, formed by a 15–25 µm thick layer of loosely packed, more or less periclinal, 4–5 µm thick hyphae supported by a 30–45 µm high 'medullary' layer of spaced groups of more densely packed, anticlinal, 4–5 µm thick hyphae; photobiont layer 55–80 µm thick, aeruginous-green; medulla 65–90 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore developed as rounded to irregular to elongate, resupinate patches forming diffusely concentric lines,



patches up to 5 mm long and up to 1 mm broad, with cream-coloured, smooth surface and indistinct felty margins; hymenophore in section 60–90 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COSTA RICA. Cartago: Tapantí National Park, Tres de Junio; 09°40'N, 83°51'W, 2700 m; disturbed upland peat bog with scattered shrubs and *Blechnum*; 21 May 2012, Dal Forno 1701 (CR **holotype**; GMUF **isotype**); *ibid.*, Dal Forno 1700 (CR, GMUF **paratypes**). COSTA RICA. San José: Los Santos Forest Reserve, Cerro de la Muerte; 09°34'N, 83°45'W, 3400–3500 m; paramo; 21 May 2012, Dal Forno 1711 (CR, GMUF **paratypes**). Puntarenas: Las Cruces Biological Station; 08°47'N, 82°57'W, 1200 m; 15–16 September 2007, Lücking & Rivas Plata 21011 (B, CR **paratypes**). La Amistad Pacífico Conservation Area, Chirripo National Park (Cerro Chirripó); 22 January 1996, Quesada 1304 (CR, GMUF **paratypes**).

Distribution and ecology: Known from paramo and subparamo areas in the Cordillera de Talamanca (Cerro de la Muerte and Chirripo National Park) in Costa Rica. The species is found commonly on the ground in paramos and in exposed subparamo bogs associated with subandine forest.

Notes: *Cora terrestris* is a small to medium-sized, terrestrial species occurring in both paramo and montane forest. It is similar in overall morphology to several other ground-dwelling species. *Cora celestino* from Colombia (see above) has more strongly undulate lobes and a collapsed-compacted cortex. *Cora casasolana* from Mexico, *C. caliginosa* from Peru and *C. pichinchensis* from Ecuador (see above), all mid-sized terrestrial species from montane rain forest or paramo areas, differ in their distinctly darker colour when hydrated, whereas *C. arachnodavidea* and *C. dewisanti* (see above) have a pilose-tomentose upper surface.

***Cora terricoleslia* Wilk, Dal Forno & Lücking spec. nov.**

Index Fungorum: 552445; **Faces Of Fungi:** 02600; Fig. 11C

Etymology: The name is a combination of a reference to the terricolous habit and David's second name, Leslie.

Holotype: Wilk 2607 (KRAM).

ITS barcoding sequence: KJ780370, KJ802419 (holotype; KJ802419 from 454 pyrosequencing).

Diagnosis: A small, terricolous *Cora* growing directly on soil close to the ground, with macrosquamulose thallus and brown, rugose lobes when fresh, becoming whitish towards the margins and with thick, brown margins.

Thallus terricolous, growing directly on soil, macrosquamulose, up to 3 cm across, composed of 10–20 semicircular to flabellate, adnate, adjacent lobes; individual lobes 0.3–0.5 cm wide and 0.5–1 cm long, moderately to frequently branched, without radial branching sutures, surface brown when fresh, without concentric colour zonation but becoming whitish towards the margin, with thick, involute, brown margins, becoming dark grey with whitish margins in the herbarium. Upper surface rugose when fresh and dry, glabrous; involute margins somewhat granular (but not sorediate) and minutely pilose; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), grey-brown when fresh, becoming grey in the herbarium. Thallus in section 300–400 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex compacted, formed by a 50–80 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae, separated from the photobiont layer by a thin layer of brownish hyphae; photobiont layer 150–200 µm thick, orange-brown above, aeruginous-green below; medulla 50–100 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: BOLIVIA. La Paz: Murillo, Chackaltaya; 16°21'S, 68°08'W, 4980 m; 9 December 2004, Wilk 2607 (KRAM **holotype**; B, LPB **isotypes**).

Distribution and ecology: Only known from type locality in the Bolivian high Andes, growing terrestrial closely adnate to the ground, associated with mosses in high altitude puna vegetation; the reported altitude of 4980 m is the highest for any species of *Cora* reported so far.

Notes: *Cora terricoleslia* is morphologically and ecologically similar to *C. squamiformis* (Fig. 11D; Lücking et al. 2013a) and can be considered a cryptic relative of the latter, since the two are closely related, although not direct sister species (Lücking et al. 2014b). Apparently, the isolated occurrence at high altitude in the Bolivian Altiplano of these species lead to microspeciation, and it can be expected that more species of this group occur in the Central Andes.

***Cora udebeceana* Moncada, R. Peláez & Lücking spec. nov.**

Index Fungorum: 552446; **Faces Of Fungi:** 02601; Fig. 11E

Etymology: The name is a word play of the acronym of the herbarium of the District University Francisco José de Caldas in Bogotá, Colombia, UDBC (u-de-be-ce), by now harboring the largest lichen collection in Colombia, with nearly 19,000 catalogued specimens.

Holotype: Moncada et al. 6158 (UDBC).

ITS barcoding sequence: KJ780520 (holotype).

Diagnosis: A mid-sized, epiphytic montane rain forest *Cora* with aeruginous green lobes with shallowly undulate surface when fresh and corticioid hymenophore forming concentrically arranged patches.

Thallus epiphytic on tree branches and twigs, between and partly overgrown by bryophytes (hepatics), foliose, up to 7 cm across, composed of 3–7 semicircular, adjacent to subimbricate lobes; individual lobes 1–3 cm wide and 1–3 cm long, sparsely to moderately branched, without distinct, radial branching sutures, surface aeruginous green when fresh, with slight concentric colour zonation, with thin, involute, light grey margins, becoming bluish grey in the herbarium. Upper surface shallowly undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), green-grey mottled with white when fresh, becoming bluish grey in the herbarium. Thallus in section 120–150 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex compacted, formed by a 20–30 µm thick layer of densely packed, irregularly arranged to periclinal, 4–5 µm thick hyphae; photobiont layer 70–100 µm thick, aeruginous-green; medulla 20–30 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore corticioid, developed as rounded to elongate, resupinate patches forming diffusely concentric lines, patches 0.5–1 mm long and 0.5–3 mm broad, with whitish to cream-coloured, smooth surface and rough, involute margins; hymenophore in section 80–100 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: Junín, Peña de Santa Bárbara Natural Reserve; 04°49'N, 73°45'W, 2520 m; 11 November 2012, Moncada et al. 6158 (UDBC **holotype**; B **isotype**).

Distribution and ecology: Known only from the type location in montane rain forest in Central Colombia, growing epiphytically on branches of trees.

Notes: *Cora udebeceana* is one of several mid-sized, epiphytic, green species lacking medullary papillae, also including *C. canari*, *C. smaragdina*, *C. suturifera* (see above), and *C. verjonensis* (see below). *C. canari*, *C. smaragdina*, and *C. verjonensis* can be distinguished chiefly by the viaduct-shaped versus compacted cortex, whereas *C. suturifera* differs in the conspicuous branching sutures.

***Cora urceolata* Moncada, Coca & Lücking spec. nov.**

Index Fungorum: 552447; **Faces Of Fungi:** 02602; Fig. 11F

Etymology: The epithet refers to the strongly concave, almost urceolate lobes.

Holotype: Coca 1956 (FAUC).

ITS barcoding sequence: KJ780677 (holotype), KJ780452 (paratype).

Diagnosis: A very small, terricolous *Cora* with olive-brown lobes when fresh, much branched and hence appearing as with ear-shaped marginal lobules.

Thallus terricolous, close to the ground between bryophytes and other lichens, macrosquamulose, up to 2 cm across, composed of 3–10 semicircular to almost circular, concave, subimbricate lobes; individual lobes 0.3–0.5 cm wide and 0.3–0.7 cm long, moderately to frequently branched, without radial branching sutures, surface olive-brown when fresh, without concentric colour zonation, with thick, prominent, involute, brown margins, becoming dark grey with light grey margins in the herbarium. Upper surface uneven when fresh, rugose when dry, glabrous; involute margins glabrous or sparsely pilose on the underside; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), cream-coloured when fresh, becoming light grey in the herbarium. Thallus in section 200–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex compacted, formed by a 30–50 µm thick layer of densely packed, periclinal, 4–6 µm thick hyphae photobiont layer 130–170 µm thick, orange-brown above, aeruginous-green below; medulla 30–50 µm thick; clamp connections absent, papilliform hyphae absent. Hymenophore not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Distrito Capital: Bogotá, paramo of Sumapaz; 04°17'N, 74°13'W, 3730 m; 3 December 2011, Coca 1956 (FAUC **holotype**; B, F **isotypes**); ibid., Lücking & Moncada 34111 (B, UDBC **paratypes**).

Distribution and ecology: Known from paramo regions in central Colombia, growing on the ground in hidden places between other lichens and bryophytes.

Notes: *Cora urceolata* is most similar to other small, brown, terricolous or saxicolous species, particularly the saxicolous *C. fuscodavidia* and the terricolous *C. pseudobovei* and *C. terricoleslia* (see above). These taxa are morphologically almost indistinguishable but differ in part in anatomical features. Thus, the usually sorediate, saxicolous *C. fuscodavidia* has a viaduct-shaped cortex, whereas in the other species it is (collapsed-)compacted. *Cora terricoleslia* has a thicker thallus and thinly pilose lobe margins, whereas *C. pseudobovei* is difficult to separate from *C. urceolata* phenotypically but not closely related.

***Cora verjonensis* Lücking, Moncada & Dal Forno spec. nov.**

Index Fungorum: 552448; **Faces Of Fungi:** 02603; Fig. 11G, H

Etymology: The epithet refers to the type locality.

Holotype: Lücking & Moncada s.n. (UDBC).

ITS barcoding sequence: KX772457 (holotype), KJ780467 (paratype).

Diagnosis: A medium-sized, epiphytic *Cora* with aeruginous to emerald-green, concentrically undulate lobes with adnate, confluent hymenophore.

Thallus epiphytic on branches of paramo shrubs, foliose, up to 10 cm across, composed of 3–5 semicircular, adjacent lobes; individual lobes 1–2 cm wide and 1–2 cm long, sparsely to moderately branched, with short, radial branching sutures, surface aeruginous to emerald-green when fresh, with slight concentric colour zonation, with thin, involute, greyish margins, becoming grey in the herbarium. Upper surface shallowly undulate when fresh, rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), whitish when fresh, becoming light grey in the herbarium. Thallus in section 200–250 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 20–30 µm thick layer of loosely packed, irregularly arranged, 4–6 µm thick hyphae supported by a 50–70 µm high ‘medullary’ layer of spaced groups of irregularly arranged, 4–6 µm thick hyphae; photobiont layer 50–100 µm thick, aeruginous; medulla 30–50 µm thick, hydrophobic; clamp connections absent, papilliform hyphae absent. Hymenophore developed as rounded to irregular, resupinate, adnate, emarginate patches soon becoming confluent, patches 0.5–2 mm long and broad but covering larger areas when confluent, with whitish to cream-coloured, smooth surface and indistinct margins; hymenophore in section 80–110 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 20–30 × 4–6 µm; basidia 25–35 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COLOMBIA. Cundinamarca: Choachí, Matarredonda Ecological Park, El Verjón; 04°33' N, 74°00' W, 3220 m; 23 January 2011, Lücking & Moncada s.n. (UDBC **holotype**; B **isotype**), Moncada 4604b (B, UDBC **paratypes**).

Distribution and ecology: Wet paramos above 3000 m of the northern Andes (Colombia), known only from the type locality, growing epiphytically on paramo shrubs.

Notes: This species is similar to the Ecuadorian *Cora canari* (see above) in substrate ecology, size, and colour. It differs in the less distinct concentric surface undulations. Unfortunately, the hymenophore is not known from *C. canari*, but likely it will provide additional diagnostic characters. Both species are not closely related (Lücking et al. 2014b).

***Cora viliewoa* Lücking, Chaves & Soto-Medina spec. nov.**

Index Fungorum: 552449; *Faces Of Fungi*: 02604; Fig. 11I–L

Etymology: The epithet is a syllable anagram derived from the second syllables of the name David Leslie Hawksworth.

Holotype: Lücking 16563 (CR).

ITS barcoding sequence: EU825956 (holotype), KJ780634, KX772503, KX772504 (paratypes).

Diagnosis: A mid-sized, epiphytic montane rain forest *Cora* with bluish green, marginally branched lobes and reticulate hymenophore.

Thallus epiphytic on tree branches, foliose, up to 7 cm across, composed of 3–7 semicircular, adjacent to subimbricate lobes; individual lobes 1–2 cm wide and 1–2 cm long, moderately to frequently branched, especially marginally, with short, radial branching sutures, surface bluish green when fresh, with slight concentric colour zonation, with thin, involute, grey margins, becoming bluish grey in the herbarium. Upper surface uneven to very shallowly undulate when fresh, rugose when dry, glabrous; involute margins glabrous; lower surface ecorticate, felty-arachnoid (representing the exposed medulla), grey when fresh, becoming bluish grey in the herbarium. Thallus in section 120–150 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex collapses-compacted, formed by a 20–30 µm thick layer of densely packed, irregularly arranged, 4–5 µm thick hyphae; photobiont layer 50–100 µm thick, aeruginous; medulla 20–30 µm thick; clamp connections absent but medullary hyphae with numerous papilliform, short, unbranched hyphae 3–4 µm thick. Hymenophore developed as rounded to linear, resupinate patches forming concentric lines, partly becoming anastomosing and reticulate, patches 0.5–1 mm long and 0.5–5 mm broad, with pale yellowish, smooth surface and smooth to rough, involute margins; hymenophore in section 100–120 µm thick; hymenium composed of numerous, palisade-like basidioles and scattered basidia; basidioles 25–35 × 4–6 µm; basidia 30–40 × 4–6 µm, 4-sterigmate; basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: COSTA RICA. Cartago: Tapantí National Park; 09°45' N, 83°47' W, 1400–1600 m; 2 April 2003, Lücking 16563 (CR **holotype**; B **isotype**). COLOMBIA. Valle: Dagua, El Queremal; 03°32' N, 76°43' W, 1600 m; 2013, Soto 104, 106 (B, CUVC **paratypes**). ECUADOR. Pichincha: Cantón San Miguel de Los Bancos, Las Cascadas near Mindo; 00°05' N, 78°46' W, 1417 m; Dal Forno et al. 1921 (GMUF, QCNE **paratypes**).

Distribution and ecology: Comparatively widespread, known from Costa Rica, Colombia, and Ecuador, in Costa Rica the only *Cora* species thus far found in the montane rain forest of the eastern slopes of the Talamanca ridge,

growing epiphytically on tree branches and rarely on leaves in shaded condition.

Notes: *Cora villiewoa* is an epiphytic montane rain forest species, differing from similar epiphytic species chiefly in the distinctly bluish tinge in the field and in the habitat ecology, since other similar species are found at higher altitudes in the paramo zone. In contrast with most other *Cora* species, this taxon is here accepted as widespread, although the four available samples show distinct phylogenetic structure, indicating that up to three species may be involved. However, the few specimens are morphologically rather uniform, so that we refrain from separating them formally with the limited material available.

***Cora yukiboa* Mercado-Díaz, Moncada & Lücking spec. nov.**

Index Fungorum: 552450; *Faces Of Fungi*: 02605; Fig. 11M–O

Etymology: The epithet honours Yukibo, taíno chief or “cacique” of the Dagua “yucayeque” (village) in Puerto Rico where the type locality is situated. This region is now composed by the municipalities Luquillo, Fajardo, Río Grande, Naguabo and Ceiba.

Holotype: Mercado-Díaz s.n. (UPR).

ITS barcoding sequence: KX772744 (holotype).

Diagnosis: A medium-sized to large, epiphytic *Cora* with bluish to greenish grey, concentrically undulate lobes when fresh and distinct, long, radial branching sutures.

Thallus epiphytic on twigs of trees and shrubs, foliose, up to 15 cm across, composed of 5–15 semicircular, adjacent to subimbricate lobes; individual lobes 1–4 cm wide and 1–4 cm long, moderately to frequently branched and with long, distinct, radial branching sutures, surface bluish to greenish grey when fresh, with concentric color zonation when drying, with thin, involute, light grey margins. Upper surface broadly undulate when fresh, undulate-rugose when dry, glabrous; involute margins glabrous to minutely pilose-setose close to the sutures; lower surface ecorticate, finely arachnoid (representing the exposed medulla), concentrically green-grey when fresh, becoming white-grey in the herbarium. Thallus in section 250–330 µm thick, with upper cortex, photobiont layer, and medulla; upper cortex diffusely viaduct-shaped, formed by a 15–30 µm layer of moderately to densely packed, irregularly arranged to more or less periclinal, 4–6 µm thick hyphae supported by a 40–100 µm high ‘medullary’ layer of spaced groups of irregularly arranged to anticlinal, 4–6 µm thick hyphae; photobiont layer 60–150 µm thick, yellow-green above, aeruginous-green below; medulla 75–150 µm thick; clamp connections absent, but lower medullary hyphae with numerous papilliform to coralloid hyphae. Hymenophore developed as irregular to angular or elongate, resupinate patches dispersed on the underside,

patches 1–5 mm long and 3–15 mm broad, with pale to cream, smooth surface and involute margins; hymenophore in section 100–120 µm thick, composed of a paraplectenchymatous layer resting on loose, 4–6 µm thick, generative medullary hyphae and supporting the hymenium. Basidia, basidioles and basidiospores not observed. Chemistry: No substances detected by TLC.

Material examined: PUERTO RICO. Río Grande: Guzmán Arriba, El Yunque National Forest, Pico El Toro; 18°16'N, 65°50'W, 1074 m; 2 October 2011, Mercado-Díaz s.n. (UPR **holotype**; F **isotype**).

Distribution and ecology: *Cora yukiboa* was found in exposed conditions in summit forests of El Toro peak in El Yunque National Forest, at 1074 m. This area is classified as lower montane wet forest. The species is also expected to occur in high elevation, undisturbed rain forests in this region. Thus far the species is only known from the type locality in Puerto Rico, growing epiphytically on shrubs.

Notes: *Cora yukiboa* resembles *C. suturifera* (see above) in morphology and ecology, particularly the much branched lobes with distinct branching sutures; however, *C. yukiboa* has a bluish tinge when fresh. Additionally, the branching sutures and lobe margins in *C. yukiboa* are mostly glabrous, whereas in *C. suturifera* they tend to be setose. The two species are not related; instead, the strongly supported sister species of *C. yukiboa* is a yet undescribed species from Brazil. Considerable fieldwork around the island lead us to conclude that *C. yukiboa* is the only species of *Cora* in Puerto Rico, and since it is restricted to the rain forests in El Yunque National Forest, its habitat is legally protected. However, because it prefers growing in water saturated conditions in high elevation forests in El Yunque, climate change might cause reductions in the areas where it is distributed.

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